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DOCTOR OF PHILOSOPHY

Approach and avoid responses to Valenced Stimuli

Bamford, Susan

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APPROACH AND AVOID RESPONSES TO VALENCED STIMULI

Susan Bamford

A thesis submitted to the School of Psychology, Bangor University, in fulfillment of the requirements of the Degree of Doctor of Philosophy.

November 2007

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"A PhD is about finding out more and more about less and less until one eventually knows everything about nothing"

Anon

"The last thing one finds in writing a book is what to put first."

Blaise Pascal (Philosopher and Mathematician, 1623-1662)

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Summary

Affective priming studies have demonstrated that most stimuli are unintentionally, and in that sense automatically, evaluated. One functional explanation for this automatic evaluation is that it exists to predispose appropriate behaviours, allowing them to be executed rapidly and efficiently. Using a lever based experiment Chen and Bargh (1999) have shown that pleasant evaluations predispose approach movements and unpleasant evaluations predispose avoid movements.

A key aim of this thesis was to develop an approach/avoid paradigm suitable for patient testing. Whilst the evaluation stage has been extensively studied in patients, the behavioural stage has received less attention. Understanding the approach/avoid mechanism and the brain structures involved is important in predicting and treating the behavioural problems occurring after brain injury. Thus, I created an approach/avoid task using a touch-screen, and lateralized the stimuli to make it suitable for patient testing. This task produced large reliable congruency effects; following explicit evaluation healthy participants were unintentionally faster to approach pleasant and avoid unpleasant stimuli than vice versa. Despite several attempts, no congruency effects were seen following automatic evaluation.

Using healthy participants I determined the time-course of the approach/avoid predisposition following explicit evaluation. Further, by reversing the meaning of the response effects in the task I reversed the congruency effect, and showed that the predisposed behaviours following explicit evaluation are goal based and semantically determined, rather than being specific inflexible movements.

The performance of a confabulatory right frontal lobectomy patient on the task suggested that confabulation might be caused by an imbalance in the approach/avoid system, hypothesized to be lateralized across the frontal lobes. I also showed that uni-lateral left-sided amygdala damage slows the evaluation of contra-lesional unpleasant stimuli but does not impair the subsequent approach/avoid behaviour.

Thus, this thesis consolidates two previously unconnected strands of psychological research; approach/avoid research and neuropsychological patient based work.

Chapter 1.

Introduction

Overview.

Crucial to survival is the ability to detect threatening and desirable stimuli and to respond appropriately. This thesis investigates the necessary conditions for producing approach and avoid responses. Several researchers have contributed to this topic but have concentrated on healthy participants, yet for other topics, experiments with patients with specific brain damage have provided significant results. A key aim of this thesis was to develop an approach/avoid paradigm suitable for patient testing. My most recent work applies this paradigm to patients with frontal and amygdala damage, and maps out the brain structures involved in approach and avoid responses.

This thesis examines and consolidates techniques from two strands of psychological research: neuropsychology and cognitive social psychology. Specifically, the approach/avoid research from cognitive social psychology was adapted and extended, and then applied to patients with specific forms of brain damage.

Neuropsychological research utilizes the logic that if damage in a particular part of the brain causes a particular deficit then this brain structure must be responsible for normal functioning in that domain. In the area of emotion, much patient based research has concentrated on the role of one particular structure, the amygdala, in the recognition of fear, (Calder, Lawrence, and Young, 2001).

Studies investigating the role of the amygdala have explored the recognition of facial expressions of a distinct set of emotions - fear, anger, sadness, surprise, happiness, and disgust - in patients with bilateral and unilateral damage to this

structure. Most research has concluded that amygdala damage impairs recognition of fear, (Anderson & Phelps, 2001; Broks et al, 1998; Calder, Young, Rowland, Perrett, Hodges, and Etcoff, 1996; Adolphs, Tranel, Damasio, and Damasio, 1995) and some have shown that, to a lesser extent, recognition of anger and disgust is also hampered, (Anderson et al, 2000; Calder et al, 1996; Adolphs, Tranel, Damasio, and Damasio, 1994).

Research looking at the purpose of the frontal lobes has studied patients who, after sustaining damage to these areas, produce startling confabulatory beliefs. One theory is that approach and avoid systems are lateralized in the frontal lobes. These might normally operate as opponent processes, to ensure stable and regulated behavior. Damage to either the approach or avoid systems would leave the other one unchecked, or at least less regulated than normal. For example a disruption to the avoid system might leave patients susceptible to the unchecked belief in and pursuit of desired outcomes and fantasies. This is strongly supported by recent findings showing that confabulatory patients have a clear positive emotional bias in the world they describe (Turnbull, Berry, and Evans 2004). Further research is needed to test this hypothesis directly.

Thus neuropsychological research has implicated the amygdala, along with other subcortical structures such as the pulvinar, in the detection and recognition of negative emotions, particularly fear and threat. And it has produced evidence that approach and avoid tendencies may be located in the frontal lobes and be involved in confabulatory beliefs.

Research on emotion from the cognitive social psychology perspective has focused on the purpose of a well-known psychological phenomenon – automatic evaluation. Automatic evaluation has been demonstrated in affective priming.

Affective priming is a form of semantic priming where an affective adjective is evaluated as positive or negative more quickly if a preceding word is of the same valence. Thus the preceding word must have been evaluated automatically. This has been shown in numerous tasks with numerous different types of stimuli (Fazio, Sabonmatsu, Powell, and Kardes, 1986; Bargh, Chaiken, Govender, and Pratto, 1992; Hermans De Houwer and Eelen, 1994; Fazio, Jackson, Dunton and Williams, 1995; De Houwer and Eelen, 1998; Hermans, De Houwer, and Eelen, 2001).

From the affective priming research Bargh et al (1992) claimed that all things in the world are automatically evaluated as good or bad. Research then focused on the purpose of this phenomenon. Chen and Bargh (1999) ran a lever-based experiment in which participants were presented with 92 valenced words. Those in the congruent condition were instructed to push a lever away from them if they disliked the word and to pull the lever towards them if they liked the word. Those in the incongruent condition were instructed to do the opposite. The time between the word appearing and the lever being moved 10 degrees in the correct direction was recorded.

Chen and Bargh (1999) found that participants in the congruent condition had faster responses than participants in the incongruent condition. And this *congruency effect* was considerable - a 267ms difference on average. This experiment demonstrated a link between conscious evaluation and subsequent motor responses; specifically that pulling is faster following a positive evaluation, and pushing is faster following a negative evaluation. Thus, Chen and Bargh claimed that pulling was an approach movement and that pushing was an avoid movement.

Chen and Bargh (1999) went on to run an automatic evaluation version of this task. In this experiment participants were presented with the valenced words, but this time no instruction to evaluate them was given. Instead, participants were instructed

to always pull the lever towards them or always push the lever away from them upon presentation of the word.

Results showed faster responses in congruent trials (pulling the lever when a positive word appeared, pushing the lever when a negative word appeared) than in incongruent trials (pushing when positive words appeared, pulling when negative words appeared). This difference was much smaller than when participants intended to evaluate the words - only a 9ms difference.

From this Chen and Bargh (1999) concluded that the automatic evaluation effect occurred in order to prime appropriate approach and avoid behaviours. Evaluation predisposed these behaviours; so if something is evaluated as good a pulling action will be primed and executed more rapidly than a pushing action, and if something is evaluated as bad then a pushing action is primed and will be executed more rapidly than a pulling motion. They argued that their experiments showed that this predisposition occurred for explicitly evaluated objects and also for "automatically" evaluated objects. Evaluation is considered to be automatic if the participant has no instruction or intention to evaluate the object. So in the absence of explicit evaluation, automatic evaluation would orient you towards appetitive or threatening stimuli and predispose you to behave appropriately.

Aims

For the thesis the intention was to extend the neuropsychological research on amygdala and frontal lobe damage using the ideas about approach and avoid behaviours from Chen and Bargh's (1999) research. Specifically, the neuropsychological research has demonstrated that the amygdala is involved in the detection of fear and threat. As an important extension to this research I sought to

elucidate whether these impairments extended to the preparation of appropriate approach and avoid behaviours. In addition I sought to determine whether problems with the predisposition to approach and avoid could be linked to confabulatory beliefs that occur after frontal lobe damage. To do this I needed to design a new paradigm suitable for patient testing.

Chen and Bargh's (1999) paradigm is not suitable for patient testing. Their task used centrally presented stimuli, which does not allow the potentially powerful comparison of ipsi and contra-lesional processing for patients with unilateral damage. In their automatic task they found effect sizes of only 9 ms, and required over 100 participants to produce a significant finding. The new paradigm needed to produce large and robust congruency effects in individuals in order to provide a sound basis for comparison in the patients. It also needed to have laterally presented stimuli, be suitable for patients who may have physical difficulties, and mobile in order to take it to patients who are unable to travel. Given the rarity of specific forms of isolated brain damage essential for this type of investigation this would be a major advancement to an existing area of research.

In addition I wanted to examine how normal controls performed on approach and avoid tasks. Firstly, I was interested in the discrepancy between the size of the congruency effect for explicit judgement and automatic judgement. The difference raises interesting questions about how adaptive this automatic preference actually is. Or in fact whether it exists at all. It has been suggested that the small effect found in Chen and Bargh's (1999) automatic task could be due to accidental explicit evaluation on some of the items Rotteveel and Phaf (2004). With regards to the patient testing it would be ideal to have a task that produces large effects in the automatic domain, thus ruling out any difficulties that might arise from possible deficits the patients may have

in explicitly evaluating objects. Thus it is important to examine this discrepancy in more detail.

Additionally I wanted to investigate the claim that pulling is an approach movement and pushing is an avoid movement. In our increasingly complex environment it is unlikely that a single set of responses would be appropriate for every situation. It seems as if the appropriate initial response of flexing or extending to pleasant and unpleasant stimuli would be influenced by situational demands. Many studies use flexing and extending positions to induce approach or avoid tendencies (Cacioppo, Priester, and Bernston, 1993; Forster, Higgins, and Idson, 1998; Neumann and Strack, 2000, Experiment 1; Forster, Grant, Idson, and Higgins, 2001; Forster 2003; Friedman and Forster 2005), so it is important to investigate whether these flex and extend movements are always rigidly linked with approaching and avoiding.

Achievements

The main achievements of this thesis are presented below.

Achievement 1. Created an approach/avoid paradigm suitable for patient testing.

Achievement 2. Demonstrated large and reliable congruency effects following explicit evaluation.

Achievement 3. Determined the time-course of this effect.

Achievement 4. Demonstrated that the predisposition to approach and avoid following evaluation is determined by semantic goal-based factors and is not simply based on rigid flex and extend movements specific to each valence.

Achievement 5. Provided the first demonstration that the situational factors that influence which approach and avoid behaviours are prepared are not limited to spatial effects but extend to non-spatial effects.

Achievement 6. Showed that confabulation might be understood as an imbalance in the approach/avoid system, and so provided a new perspective from which to view many psychological disorders.

Achievement 7. Showed that unilateral amygdala damage caused a deficit in the classification of unpleasant stimuli but that this impairment did not extend into the approach/avoid behaviours.

Thesis Structure

The thesis is separated into two parts. Those studies investigating approach and avoid responses in healthy participants will constitute the first part of the thesis. The patient based studies will constitute the second part.

So the layout of the thesis is as follows:

Chapter 2: Literature review covering research on automatic evaluation.

Chapter 3: Review of the research that suggests that explicitly evaluating a stimulus leads to a predisposition to approach or avoid. Two experiments are then presented that investigate this predisposition. The first introduces my approach/avoid paradigm and demonstrates large congruency effects using this task; participants are much faster to approach good items and avoid bad items than vice versa. The second experiment investigates the time-course of these congruency effects.

Chapter 4: Review of the literature that investigates the link between automatic evaluation and approach/avoid behaviours. Five experiments are presented in this chapter that investigate this link using an automatic evaluation version of my approach/avoid paradigm. The first three attempt to produce congruency effects following automatic evaluation. Despite several modifications, these experiments fail

to produce congruency effects. The following two experiments investigate why congruency effects following automatic evaluation are absent or small.

Chapter 5: Review of the literature that suggests that approach/avoid movements are rigidly linked to valence. I question this and examine the influence of situational factors on the predisposition to approach and avoid. Here two experiments looking at spatial response effects will be discussed, and then a further experiment looking at non-spatial response effects will be presented. This will complete the studies examining responses in healthy participants.

Chapter 6: Review of the literature on confabulation and the possible theories explaining this phenomenon. I then present the theory that confabulation may occur because of a damaged approach/avoid system. A confabulatory patient is then compared to age matched controls on my explicit evaluation approach/avoid task.

Chapter 7: Review of the literature on amygdala damage and subsequent deficits in detecting unpleasant and threatening stimuli. I investigate whether this deficit extends to the approach/avoid response in a patient with unilateral amygdala damage by comparing her responses to age matched controls on my explicit approach/avoid task.

Chapter 8: General Discussion and Conclusions.

Chapter 2

Literature Review: Affective priming and the automatic evaluation effect.

The ability to recognise threatening situations is vital for the survival of an individual, and ultimately a species. If an animal does not differentiate between predator and prey then it will not execute the right behaviour. The ability to rapidly distinguish good from bad, predator from prey, friend from foe is therefore advantageous. It has been proposed that this ability provides an advantage because the classification leads to an immediate response – approach or avoid (Chen and Bargh, 1999). This would allow the response to be incredibly efficient allowing the animal to make a wise move under strict time constraints.

For humans, life is more protected. Less often is there an actual predator and we use complex ideas and schema to make decisions. But the ability to rapidly distinguish good from bad and initialise an appropriate response still plays a powerful role. There are still situations in which rapid decisions and responses are needed for survival.

Research using different paradigms, from adaptations of semantic priming tasks to modifications of the Simon paradigm, has demonstrated that in humans classification of stimuli as good or bad is unintentional, rapid, and automatic (Fazio, Sanbonmatsu, Powell, and Kardes, 1986; Bargh, Chaiken, Govender, and Pratto, 1992; De Houwer and Eelen, 1998; Hermans, De Houwer, and Eelen, 2001). And a few studies have shown that this automatic evaluation of stimuli predisposes individuals to approach or avoid the stimuli (Chen and Bargh, 1999; Duckworth, Bargh, Garcia, and Chaiken 2002; De Houwer, Crombez, Baeyens, and Hermans, 2001). Specifically, these studies claim that stimuli in the environment are

automatically evaluated as good or bad. The good items predispose an approach movement and the bad items predispose an avoid movement. This predisposition allows a rapid and appropriate response to stimuli that may be threatening or beneficial to the individual. The proposal is, then, that to execute an appropriate behaviour, evaluation is the first step and this then leads to an appropriate response (Chen and Bargh, 1999).

There are only a small number of studies that examine approach and avoidance behaviours and these were initially executed to explain the purpose of automatic evaluation. Thus it is important to look back at the abundant literature examining automatic evaluation that inspired the approach/avoid research. So this chapter will focus on the nature of automatic evaluation, when it occurs, and what sort of information is evaluated. The more limited amount of research on the approach and avoid responses following automatic, and explicit evaluation, will follow in the experimental chapters.

In this review, then, we take a look at research that demonstrates automatic evaluation. First we look at affective priming, how it has demonstrated automatic evaluation and the generality of the effect. We then examine the possible mechanisms of affective priming and the processing of evaluative information. We will examine how the processing of semantic and affective information might interact. Finally we will take a look at the time-course of automatic evaluation effect and the possible moderating factors.

Affective priming and the automatic evaluation effect.

Fazio et al (1986) adapted a semantic priming paradigm and demonstrated that valenced words were automatically evaluated. In semantic priming a target word is identified more quickly if it is preceded by a prime word of similar meaning (Neely, 1976, 1977). For example, the target word *cat* will be identified more quickly if it is preceded by the prime word *dog* than if it is preceded by the prime word *computer*. This finding suggests that features related to the prime are automatically activated in memory, and so facilitate identification of a semantically related target word.

Fazio et al (1986) developed an affective priming paradigm from this standard semantic priming methodology. Affective words, or "attitude objects", that had been rated as good or bad by each participant were sorted on a continuum of evaluation latency. The four quickest (strong) and four slowest (weak) good and bad attitude objects for each participant were then used for the experimental task, and presented randomly before the affective adjectives. At the beginning of the trial Fazio et al presented a prime "attitude object", for example *death*, that the participants were instructed to remember. This was followed by a target affective adjective, for example *disgusting*, and the task was to identify whether the affective adjective was good or bad. At the end of each trial the participants had to say the attitude object word aloud. Fazio et al reasoned that the presentation of the attitude object should activate relevant features and evaluations, and subsequently facilitate evaluation of a similarly valenced affective adjective.

Using this paradigm Fazio et al (1986) ran three experiments and in all of them found that responding was quicker if the valence of the attitude object was

congruent with the valence of the subsequent affective adjective. The participants were not asked to evaluate the attitude object and the memory task was used as a cover story to try to prevent this. So despite the fact that the attitude object is task relevant and must be extensively processed, the results suggest that the evaluation of the attitude object is automatic, in the sense that the processing of the valence is unintentional.

Although using both strong and weak attitude objects, it is important to mention that Fazio et al (1986) only demonstrated an automatic evaluation effect with strong attitude objects (the most quickly evaluated) and not weak ones (the least quickly evaluated). They argued that strong attitudes were more accessible in memory and could therefore be accessed readily to influence a subsequent task involving a valenced item. Weak attitudes could not be accessed quickly enough to produce a large enough effect to influence a subsequent task. Fazio et al therefore concluded that evaluation occurred rapidly and unintentionally for those stimuli that evoked strong attitudes.

This claim is important because as we will see in the following chapters, the approach/avoid literature often utilizes the assumption that all stimuli are automatically evaluated regardless of attitude strength. Thus it is important to review the literature that produced such a claim.

Bargh et al (1992) disagreed with the conclusion that only strong attitudes elicited the automatic evaluation effect, and so presented 3 experiments that examined the generality of the automatic evaluation effect and that challenged Fazio et al's (1986) claim that only attitude objects evoking strong attitudes could cause the effect. Fazio et al used each participant's four strongest (fastest evaluated) and four weakest (slowest evaluated) good and bad attitude objects, so their design did not rule out the

possibility that the automatic evaluation effect could happen with all but a participant's weakest attitude objects.

In Bargh et al's (1992) first experiment they replicated and extended Fazio's design. In Fazio's et al's (1986) design strong attitude objects were those that were evaluated very quickly in a pre-experiment questionnaire. Conversely, weak attitudes were those that were evaluated very slowly in the pre-experiment questionnaire. Bargh et al added a third set of attitude objects that comprised those that had consistently been rated as positive or negative by most participants but whose evaluation latencies, and therefore strength, fell across the entire range. Following Fazio et al's procedure, Bargh et al found that responses were faster on congruent trials than on incongruent trials and that this effect held for the strong and the consistent attitude objects. This confirmed Bargh et al's hypothesis by demonstrating that automatic evaluation not only occurs for the strongest attitude objects but also can occur for attitude objects of a range of strengths.

Bargh et al's (1992) second and third experiments were designed to check that the paradigm itself was not responsible for producing the automatic evaluation effect. The second experiment introduced a two-day delay between the pre-experiment prime evaluation questionnaire and the task. Results revealed that congruent trials were responded to more quickly than incongruent trials and this occurred for strong, consistent and weak attitude objects, although the effect was only marginally reliable for the weak attitude objects. This ruled out the possibility that the automatic evaluation effect was dependent on participants having evaluated the attitude objects just prior to the experimental task.

Bargh et al's (1992) final experiment removed the memory task for half the participants who were given no explanation about the first word and were only

instructed to respond to the second word (no instructions condition). A surprise memory test of the attitude objects was presented to these participants following the experiment to assess if they had actually attended to the attitude objects.

Results revealed that participants in both conditions remembered most of the attitude objects, and therefore showed that participants in the no instructions condition must have been attending to these attitude objects. The congruent trials were responded to more quickly than incongruent trials and this occurred in both memory and no instructions conditions and for both strong and weak attitude objects, although importantly the effect was smaller for weak attitude objects. Thus, Bargh et al demonstrated a larger automatic evaluation effect for strong than for weak attitude objects, and they concluded that the automatic evaluation effect holds for most attitude objects, the exception being the very weakest (slowest evaluated) attitudes. Their study also showed that elements of the paradigm itself are not responsible for these findings. Most importantly, in their final experiment they showed that the primes were evaluated unintentionally even though they were not task relevant.

Fazio (1993) however, took issue with some points of this research and produced a paper that re-examined Bargh et al's (1992) analysis. Specifically, Fazio was concerned with the differences between his and Bargh et al's theoretical models of attitude activation. Examination of the detail of their models shows that, although both researchers demonstrate an automatic evaluation effect, Bargh et al suggested that the automatic evaluation effect was moderated by *normative* strength of attitude activation whereas Fazio (1986) claimed it was determined more so by the *idiosyncratic* strength of attitude activation. To summarize, Bargh et al had demonstrated the same Fast/Slow x Prime Valence x Target Valence interaction as Fazio (1986), which shows that the automatic evaluation effect is moderated by the

speed of the evaluation (and therefore the attitude strength) of the primes in the pre-experimental task. Bargh et al had then run a regression analysis to determine which correlates were affecting the Fast/Slow moderation. He found that normative prime evaluation latency was exerting the greatest effect. This led him to conclude that normative, rather than idiosyncratic, latency was the important moderating factor.

Fazio (1993) felt that this conclusion needed to be examined as he believed that individual variability must be important, and that any relationship between normative latency and automatic evaluation must surely occur because of a co-variation with idiosyncratic latency (or other measures of attitude strength). This led him to re-analyse Bargh et al's data with some important changes.

Fazio (1993) reciprocally transformed the data to control for the skew, he added each participant's *mean* prime evaluation latency into the equation to control for idiosyncratic response latencies, and he controlled for the non-independence of the trials by computing each participant's mean latency for the group of trials on which each prime occurred, and adding this as a covariate in the regression analyses. This would effectively remove the variance due to each participant's mean speed of responding on any trial preceded by a particular prime. Introducing any one of these changes altered the statistical outcome and only the interaction involving the idiosyncratic latency predictor variable reached significance. These changes allow the data to meet the assumptions of the regression model. If the data do not fit the model, for example if the data is skewed or if there is non-independence, then the statistical outcome can be inaccurate. Thus controlling for these factors makes Fazio's analysis more appropriate, and accurate, than Bargh et al's (1992) analysis.

Fazio's (1993) analysis also demonstrated that only the interaction involving both idiosyncratic variables - that is idiosyncratic prime evaluation latency x

idiosyncratic prime valence x target valence - was significant. This shows that automatic evaluation occurs between primes and targets that are congruent for each particular individual and the effect is moderated by the strength of that individual's attitude towards the prime. Fazio states that his results confirm that idiosyncratic attitude strength is the greatest predictor of the automatic activation of that attitude. He continues that normative strength is only a predictor to the extent that it co-varies with idiosyncratic strength.

It seems much more realistic that the automatic evaluation effect would be moderated by idiosyncratic strength. Surely when an individual evaluates the target this evaluation will be quicker if the target valence matches the prime valence and strength for that individual and not if the target valence matches the average valence and strength of the prime.

At the end of the paper Fazio (1993) clarifies his theoretical model of automatic evaluation and attitude strength stating that he did not mean to suggest that only the strongest attitudes would evoke automatic evaluation, but that instead he would suggest a continuum where in general the greater the strength of the attitude the greater its likelihood to evoke an automatic evaluation.

So the conclusion from this debate is that both researchers agree that most valenced items will be automatically evaluated, and the exception are items with very weak or neutral valence. It seems more likely to be idiosyncratic valence that drives the moderation rather than normative valence. Most items therefore are capable of influencing subsequent responses and so it is reasonable to think that this influence might extend from affecting the speed of an evaluation to affecting the speed of an action, such as an approach or avoid response.

Mechanisms driving the affective priming effect.

The affective priming effect has been demonstrated using Fazio at al's (1986) paradigm in which participants evaluate the target adjective and respond by identifying if it is *good* or *bad*. Many studies have followed Fazio's research paradigm and also demonstrated an automatic evaluation effect with numerous different stimuli. These range from affective adjectives and nouns, to black and white line drawings of objects (Giner-Sorolla, Garcia, & Bargh, 1999) colour pictures (Fazio, Jackson, Dunton and Williams, 1995; Hermans, De Houwer and Eelen, 1994) and even cross-modally with prime odours and target words (Hermans, Baeyens, & Eelen, 1998). Thus the effect is not limited to one stimuli set but seems universal.

The mechanisms driving this effect are interesting because they indicate how affective processing might be affecting subsequent responses. One theory proposes that affective priming effects occur because of a Stroop like response inhibition or facilitation (De Houwer, Hermans, Rothermund, &Wentura,1998a; Franks, Roskos-Ewoldsen, Bilbrey, & Roskos-Ewoldsen, 1998; Klauer, 1998; Klinger, Burton, & Pitts, 2000; Rothermund &Wentura, 1998;Wentura, 1999). According to this theory the prime has activated the response of *good* or *bad* and then this matches or opposes the response needed for the target adjective. When the response to the target matches that of the prime then the response to the target is faster because it is already activated. When the response to the target opposes that of the prime then the response to the target is slower because it first has to be inhibited and then the correct response produced. This explains what might be happening in the research described so far. However affective priming in a pronunciation task, and an affective Simon task, argued against this theory.

Bargh, Chaiken, Raymond, and Hymes (1996) designed the pronunciation task in order to replicate the automatic evaluation effect using a different paradigm from Fazio et al (1986), and to demonstrate the unconditional nature of the effect. Specifically, they wanted to remove the evaluative connotation of the experimental task used by Fazio et al and Bargh et al (1992) who had asked participants to evaluate the target word. Bargh et al (1996) reasoned that although conscious evaluation of the prime during the main experimental task was not required it might have occurred because participants were evaluating the target. They argued that it is unlikely that participants "switch off" from the evaluative goal for the presentation of the prime and switch back on to the evaluative goal for the presentation of the target. So they designed a different main experimental task with no evaluative basis.

Bargh et al's (1996) first experiment, then, was a pronunciation task. This task involved the presentation of the prime and then a strongly valenced adjective that the participant simply pronounced. It is important to note given the preceding debate that this analysis was carried out on transformed data using idiosyncratic prime valence evaluations and latencies. Results showed that an automatic evaluation effect occurred even though no conscious intention to evaluate within the main experimental task was required. This automatic evaluation effect occurred for both the strong and weak primes.

A second experiment was then produced to further exclude any evaluative nature of the tasks. Bargh et al (1996) considered the possibility that evaluating the primes might influence participants' responses in the main experimental task. The possibility that participants' attitudes are temporarily activated by evaluation of the primes was ruled out by the 2 day delay introduced in the Bargh et al (1992) studies, but the possibility that the evaluative goal transferred from the prime evaluation task

and persisted into the main experimental target pronunciation task remains. To rule this out Bargh et al (1996) removed the prime evaluation pre experimental task and instead used norms from Fazio et al's (1986) appendix. The results mirrored those in Experiment 1; an automatic evaluation effect occurred even though there was no conscious intention to evaluate within the experiment. Once again this automatic evaluation effect was not moderated by attitude strength and occurred for both the strong and weak primes.

A final experiment replaced the extremely valenced target words with mildly positive and negative target words to further exclude any hint of evaluative nature from the task. This experiment produced identical results to the previous two experiments. An automatic evaluation effect occurred even though there was no conscious intention to evaluate within the experiment or any strongly valenced targets. Once again this automatic evaluation effect occurred for both the strong and weak primes. The effect sizes in all 3 experiments were a difference of around 10 – 20ms between the congruent and incongruent trials, showing a stable, consistent effect.

From this series of experiments Bargh et al (1996) claimed that the automatic evaluation effect was not dependent on the participants having any intention to evaluate the stimuli during the experimental task. They concluded that "all attitude object stimuli studied were shown to trigger an immediate, reflexive, and uncontrollable good or bad response, depending on the subject's evaluation of them." They also conclude that the moderation of the automatic evaluation effect by attitude strength is a special case occurring only when there is an intentional conscious evaluation task somewhere within the experiment, and not a moderating factor under most circumstances.

The automatic evaluation effect has also been demonstrated in an affective version of the Simon paradigm (De Houwer and Eelen, 1998). The Simon paradigm comprises a relevant feature, and an irrelevant feature that needs to be ignored, but which corresponds, or not, to the required response. De Houwer and Eelen adapted this paradigm by presenting nouns and adjectives with positive, negative, or neutral valence. The task was to indicate whether the presented word was a noun or an adjective. Participants had to say "positive" for a noun and "negative" for an adjective, or vice versa. In this variation of the Simon paradigm the relevant feature was the grammatical category, the irrelevant feature was the word's valence, and the response was a description of valence. So participants would have to ignore the valence of the word. Results revealed that this was extremely difficult. Congruent trials were responded to much more quickly than incongruent and neutral trials. A further experiment that replaced the responses "positive" and "negative" with "flower" and "cancer" produced the same congruency effect. De Houwer and Eelen concluded that stimuli are evaluated involuntarily, and in that sense automatically, although again in this case the word was task relevant and so processing of other features was required.

These results, and those from the pronunciation task, are very important for the possible mechanisms by which priming effects have been proposed to occur. The pronunciation task casts doubt upon the Stroop like response conflict theory. This is because the response conflict model proposes the prime will activate particular responses of good and bad; these will then make it easier to make the response to a congruent target as the response will already be activated, and harder to make the response to an incongruent target as the response will have to override the already activated concept. But in the pronunciation task the possible responses are not limited

to *good* and *bad* and are instead numerous; the participant pronounces the target word and so the possible responses are only limited by the number of words in the experimental stimuli set. Therefore, the prime might activate the concepts of good and bad but these are not the responses needed. So it is unlikely that response conflict is occurring in the pronunciation task. In a similar argument the affective Simon effect using the responses "flower" and "cancer" cannot occur through response conflict, and so must also be occurring through a different mechanism.

An alternative model to response conflict is one of spreading activation in semantic memory. This model is based on the theory that semantic concepts are interconnected in memory. If one concept is activated then this activation spreads through the connections to activate all related concepts. The proposal is then that in affective priming the prime activates semantically related information in memory making the target more accessible if it is semantically related and less accessible if it is not related.

Explaining affective priming in terms of spreading activation models in semantic memory falls short as the only semantic property linking the prime and target in the pronunciation task is the valence. Bargh et al (1996) therefore attempt to explain the mechanism by stating that it must be the case that all positively (negatively) valenced items activate all other positively (negatively) valenced items. However, the number of positive or negative items in memory must be very large, and so this explanation depends upon a great number of items being activated all at once, and a great number of items being inhibited all at once. The fan effect (Anderson and Bower, 1973) suggests that there is a limited amount of activation possible at one time, so that if many items are activated at once the strength of the activation is spread out between them. Thus, if all items of the same valence are activated all at once then

any individual item should only enjoy a very small increase in activation. This level of activation is unlikely to influence a response to the item, (Spruyt, Hermans, De Houwer & Eelen, 2002). This means that the spreading activation account is also problematic.

Given these problems with the spreading activation account of affective priming, Spryut et al (2002) suggested that a distributed memory model is more likely. This model posits that memory of an item has a characteristic pattern of activation, and so similar items have similar patterns. Changing from the pattern of the first item to the pattern of the second requires only small modifications if the items are similar and so response to the second item is speeded. This model solves the fan effect problem and provides a possible explanation for automatic evaluation in the pronunciation and affective Simon tasks.

The demonstration of an affective priming effect in these tasks was therefore important in suggesting the generality of the effect but also had strong consequences for previous theories on the mechanisms of the effect. Specifically, the pronunciation task shows that response conflict is not the only factor driving the affective priming effect, and that other mechanisms, such as spreading activation, need to be considered. This led to interest in the pronunciation task from other researchers.

Klauer and Musch (2001) produced a series of affective priming experiments to provide a more detailed examination of the affective priming effect in the pronunciation task. But the focus shifted to address potential moderators of the effect when a difficulty in replicating it was encountered. Across five experiments they: varied prime-set and target-set size, varied the SOA, replicated Bargh et al (1996, Experiment 2), and investigated the orthographical depth of English versus German language as a possible moderator. In all five experiments they failed to produce

affective priming effects. The findings of these experiments cast doubt on the claims made by Bargh et al on the unconditional nature of affective priming effects. This is in line with other research that has encountered difficulties reproducing affective priming effects (De Houwer & Hermans, 1999; Glaser & Banaji, 1999)

Spruyt et al (2002) produced 3 experiments showing that stimulus modality moderates the affective priming effect. They varied the stimulus modality of the prime-target pairings (picture-picture, picture-word, word-word, word-picture), and they showed that when pictures were used as primes, affective priming occurred in the pronunciation task. They did not produce an affective priming effect when words were used as primes. So far pronunciation tasks had only used words and so this showed that stimulus modality could affect when evaluation occurs. It seems from this study that pictures are more easily evaluated, however pronunciation tasks with words have produced automatic evaluation effects (Bargh et al, 1996) and so it is not clear what enabled these effects in Bargh et al's study and prevented them in Klauer and Musch's study (2001).

Spruyt et al (2002) discuss how their findings relate to the proposed models of Stroop-like response interference and semantic activation in the production of the affective priming effect. The pronunciation task effectively removes the possibility of Stroop-like response conflict, and so affective priming in this task can only be explained if the primes influence the encoding of the target in some way, for example by semantic activation. Pictures, they explain, more readily activate semantic processing, than do words, as this semantic processing is essential in determining what the pictures are and then categorizing and naming them. Words on the other hand can be processed more superficially, and can be a simple mapping of letters to sounds with less semantic influence. So they theorized that pictures would make

better primes than words, because pictures activate more semantic processing and the possibility of facilitating or inhibiting the processing of the target is therefore increased. Their findings support this idea and show that in their study using pictures as primes creates an affective priming effect whilst using words as primes does not. This lends support to the idea that semantic processes play a role in the affective priming mechanism.

In summary, the evaluative task suggests that affective priming occurs through response competition. Pronunciation tasks remove the possibility of response competition and so argue that another semantic based mechanism must be at work. However, difficulties in replicating affective priming in the pronunciation task suggest that affective priming through this semantic based mechanism may not be robust and may depend on moderating factors. Thus, the mechanisms that are involved in the affective priming effect are complex and may vary with different task demands (see De Houwer, Hermans, Rothermund, and Wentura, 2002 for a detailed proposal).

What is clear is that valence can be unintentionally, and in that sense automatically, detected and it seems that affective processing might influence subsequent responses via more than one mechanism. As semantic based mechanisms seem to be a strong candidate in some circumstances, such as the pronunciation task, it is useful to look at how semantic and affective processes are linked and perhaps uncover the potential moderating factors in semantic based affective priming.

Role of semantic encoding in affective priming.

There are a number of studies that argue for the importance of semantic encoding in affective priming. Some have shown that when semantic encoding is needed for the task affective priming occurs, but when semantic encoding is not necessary affective priming does not occur (De Houwer, Hermans, and Spruyt 2001, De Houwer and Randell, 2004). Therefore it is argued that semantic encoding must be an important part of affective priming. In a slightly different argument Storbeck and Robinson claim that semantic encoding is the preferred method of encoding and that affective processing only occurs after more refined semantic encoding or under particular task circumstances. There are also arguments against the role of extended semantic mechanisms, such as spreading of activation, in affective processing, such as studies that show affective priming can occur through response competition mechanisms in which extended semantic processing is not necessary. Thus the picture is complex. These arguments will be reviewed in more detail starting with the studies that manipulate the amount of semantic encoding needed.

De Houwer et al (2001) used a pronunciation task with degraded target words. This increased the processing time, and so, they argue, the amount of semantic encoding needed. When the targets were degraded they produced an affective priming effect whereas using un-degraded target words did not.

More recently De Houwer and Randell (2004) systematically varied the amount of semantic information that was needed to complete a pronunciation task. The participants in each condition performed identical tasks but used different selection rules to do so, either making a decision based on semantics or based on perceptual characteristics. Results showed affective priming only in the semantic task. A second experiment showed that by increasing the amount of semantic processing needed, by

changing the semantic task from the word/non-word decision task used in Experiment 1 to a task in which participants pronounced the word unless it was the name of an occupation, a larger effect size was demonstrated.

Both studies show that there seems to be a relationship between semantic encoding and the likelihood of affective priming. These studies conclude that semantic encoding is important for affective processing. If this is the case it may explain some of the failed affective priming effects in the pronunciation task (Klauer and Musch, 2001); that is these failings may occur when semantic encoding is not necessary. An alternative hypothesis is that these studies could mean that affective processing builds over time and that increasing the time needed to complete the task allows affective processing to occur, although as we will see later the time course of automatic evaluation suggests that automatic evaluation occurs immediately and decays rapidly by around 300ms. This makes the authors conclusion the most likely.

This conclusion has been supported by results from the affective Simon effect. De Houwer, Crombez, Baeyens, and Hermans (2001) examined the generality of the affective Simon effect and used black-and-white and colour pictures of man-made and natural objects as stimuli. Participants performed one of two tasks. The semantic task required participants to say "positive" if the picture depicted a man made object and "negative" if the picture depicted a natural object. The perceptual task required participants to say "positive" if the picture was black-and-white and "negative" if the picture was in colour. In the semantic task an affective Simon effect was found. But in the perceptual task no affective Simon effect was found. The lack of an affective Simon effect in the perceptual task suggests that semantic representations need to be activated before a participant can determine the valence of an object. Thus the results

from an affective Simon paradigm support the idea that semantic encoding is important for affective processing.

The second set of studies examining the role of semantic encoding are those by Storbeck and Robinson (2004). These claim that semantic encoding is the preferred route and that affective processing only occurs after more refined semantic encoding or under particular task circumstances. Storbeck and Robinson systematically compared affective and semantic priming; they ran five experiments varying stimulus modality and task type to elucidate when affective and semantic processing occurs.

The first experiment was a lexical decision task. The lexical decision task was chosen because an evaluative task, such as the Fazio (1986) paradigm, draws attention to valence and would favour affective processing by a response competition mechanism; the lexical task does not favour either affective or semantic processing by response competition (De Houwer, 2003) allowing a fair measure of spreading activation of affective versus semantic priming. Stimuli were words that came from two semantic categories (animal and religion), and from the two affective categories (good and bad). Primes and targets could be semantically congruent (animal-animal, religion-religion) or semantically incongruent (animal-religion, religion-animal), and affectively congruent (good-good, bad-bad) or affectively incongruent (good-bad, bad-good). The results showed that priming occurred for semantic category but not for affective category. This suggests that semantic but not affective priming has a spreading activation element. It also shows that semantic and affective processing are dissociable; semantic processing can occur without affective processing taking place.

In Experiment 2, Storbeck and Robinson (2004) sought to address the extent of affective and semantic priming in an evaluative priming task that should favour

affective priming. Thus Experiment 1 was replicated but with the change in the task. Participants now had to categorize targets as good or bad. Results mirrored those of Experiment 1; once again semantic priming occurred but not affective priming. So in both a lexical decision task, and an evaluative task that draws attention to valence and introduces a response competition variable, which should favour affective processing, only semantic processing occurs. The authors therefore conclude that semantic processing is the favoured encoding process.

To check whether the variation in semantic categories may have been responsible for dampening the affective priming effect, Experiment 3 was a replication of Experiment 2 but participants only saw stimuli from one of three semantic categories (animal, religion, or texture) in each of the three blocks. Results showed that affective priming occurred equally for each semantic category. Thus showing that the primes used in Experiments 1 and 2 are capable of producing affective priming effects, and that varying semantic category is enough to wipe out the affective priming. The results of the three experiments suggest that affective priming is not as robust as previously thought and that semantic priming occurs more readily. Thus, showing that semantic information appears to be the stronger more preferred route of encoding. Storbeck and Robinson claim that this suggests that automatic evaluation may not be as obligatory as first claimed (by Bargh et al 1992) and may only occur when semantic encoding only yields minimal information for that context.

Storbeck and Robinson (2004) then performed two final experiments using pictures as the stimuli instead of words. Experiment 4 was a replication of a paradigm used by De Houwer and Hermans (1994) where target letter strings were superimposed onto prime pictures. Thus the primes and targets were presented

simultaneously. Prime-target pairs belonged to three different categories: in the Match Both condition they were congruent in both category and valence (e.g. the word spider presented on a picture of a spider), in the Match Affect condition they were congruent only by valence (e.g. the word spider on a picture of a snake), in the Mismatch Both condition they were incongruent with respect to both category and valence (e.g. the word spider on a rabbit picture). This was important because it allowed the authors to compare the Match Both and the Match Affect conditions. This comparison held affective congruency constant and allowed an examination of the influence of category congruence. In contrast a comparison of the Match Affect and Mismatch Both conditions held category congruence constant and allowed an examination of the influence of affective congruence. If category congruence has an effect this means that participants automatically encode semantic features of the prime. If affective congruence has an effect this means that participants automatically encode the valence of the prime.

Participants completed both lexical decision tasks and evaluative tasks. The same results were found regardless of task type; the comparison of Match Both and Match Affect categories revealed that there was a main effect for category congruence (latencies were significantly shorter for the Match Both condition than the Match Affect condition), showing that participants automatically encoded the semantic information; the comparison of Match Affect and Mismatch Both revealed that there was no main effect of affective congruence (latencies for Match Affect and Mismatch Both conditions did not differ significantly). Thus, results showed priming effects for semantic category but not affective category. The authors suggest that it is unlikely that valence is processed before a more refined semantic processing takes place.

This claim seems at odds with their earlier statement that affective processing

occurs when semantic encoding yields minimal information. On closer inspection their model suggests that when semantic information is detailed then affective processing does not automatically take place. When semantic information about the item is not available, or does not add much information, then affective processing will follow. So in both cases the semantic processing comes first. When it is adequate affective processing will not occur, but when it is inadequate affective processing follows. Note that Storbeck and Robinson (2004) are not opposing the existence of affective priming, nor are challenging the claim that automatic evaluation can occur, rather they are suggesting that semantic processing may occur first and that, under some circumstances, such as priming paradigms, may be the more robust encoding process.

Whilst both the De Houwer et al (2001), De Houwer and Randell, (2004) and Storbeck and Robinson (2004), accounts argue for a role of semantic factors in affective processing they have important differences. The former two seem to show that as the amount of semantic information needed for the task increases then affective processing is more likely. The latter suggest that as semantic processing increases the need for affective processing decreases. Thus one account suggests that semantic processing is needed for affective processing, the other suggests that semantic processing occurs instead of affective processing, and affective processing is a secondary process. Thus there are unresolved differences in the accounts of how semantic and affective processing interact, but these studies all argue that automatic affective processing depends upon semantic processing.

However, there have been studies that argue that extended semantic processing, for example by spreading of activation, does not always precede affective processing. De Houwer, Hermans, Rothermund, and Wentura (2002), showed that

task influences the type of priming that occurs. In their Experiment 2 they showed that when primes and targets were affectively related, affective priming occurred in an evaluative decision task but not in a semantic decision task. This shows that affective priming in the evaluative task can occur without a spreading activation element via a response conflict mechanism. These results are supported by Klauer and Musch (2001) who, recall, could not find an affective priming effect in several pronunciation tasks where the response conflict element had been removed and only an extended semantic mechanism remained. These results do suggest that affective priming can occur via a response competition mechanism in some circumstances, and so there are cases in which semantic information is not processed through a spreading activation network first.

The results of Klinger at al (2000) support this. They presented the prime subliminally, and introduced a response window. Using this paradigm they found that when the primes and targets were affectively related and an evaluative decision task was used then affective priming occurred. In a second experiment the primes and targets were related affectively, and also by their word or non-word categorisation, so on this latter dimension congruent pairs would be both words or both non-words and incongruent pairs were those that consisted of a word and a non-word. Participants performed the lexical decision task. This produced a lexical priming effect so that congruent word or non-word pairs were responded to more quickly than incongruent word-non-word pairs. Interestingly no affective priming occurred for the word stimuli using this lexical decision task. This shows that when response competition on an evaluative dimension was possible affective priming occurred, but when response competition was prevented on an evaluative dimension, and was instead based on a lexical dimension, affective priming did not occur. This suggests that response

competition is important in driving the affective priming effects in these experiments. But when response competition is not available, and only an extended semantic processing account could remain, then affective priming does not occur. Thus these results argue against a spreading of activation account.

Although these accounts argue against the role of extended semantic processing such as spreading of activation in a semantic network, they do not rule out semantic processing in affective priming; it is likely that all affective processing requires some semantic processing in order to determine the meaning and thus the valence of the stimuli.

The results of these studies argue against the role of extended semantic factors in affective processing, but their results are not entirely inconsistent with Storbeck and Robinson. For example, in De Houwer et al (2002), Experiment 2, the finding that affective processing is not found when semantic category varies within the targets seems to be consistent with some of Storbeck and Robinson's (2004) results, and does not contend their suggestion that affective priming can be wiped out if semantic category distinction is a strong enough basis for the decision. Storbeck and Robinson would argue that affective processing by response competition is a special circumstance in which the evaluative nature of the task and the small amount of semantic information available allows affective processing to occur without a refined semantic processing.

The emerging conclusion might be that when affective priming occurs through the response conflict mechanism in the evaluative decision task it seems the role of semantic processing is small. When affective priming occurs in the absence of response competition it occurs after extended semantic processing has taken place, perhaps by a spreading of activation account. The question is still open as to whether

this occurs because this semantic processing has not produced enough information or whether it unconditionally follows the earlier semantic processing. Thus the relationship between affective and semantic processing may be complex and task dependent, and that in some cases affective processing is occurring in addition to extended semantic processing, such as a spreading of activation account, and at other times affective processing might occur through a response conflict mechanism where the semantic processing is more limited.

Time course of the automatic evaluation effect

In the research that examines the role of semantics in affective processing several studies (De Houwer, 2001; De Houwer and Randell, 2004) show that as the task complexity, and so the time needed to complete that task increases, the likelihood of affective priming increases. So one hypothesis is that automatic evaluation takes time to appear. Hermans, De Houwer and Eelen (2001) undertook a close examination of the time course of the automatic evaluation effect. They manipulated the stimulus onset asynchrony (SOA) in an evaluative decision priming task. Five levels were used: -150ms, 0ms, 150ms, 300ms, and 450ms. Results showed that affective congruence facilitated responses only in trials with the 0ms and 150ms SOAs. This shows that automatic evaluation is in fact a rapid process. A second experiment was run using a pronunciation task. SOA was varied over three levels: 150ms, 300ms, and 1000ms. Again results showed that affective congruency facilitated responses only in the 150ms SOA condition.

In both experiments it was surprising that no effect was found at 300ms because previous studies have demonstrated automatic evaluation at this SOA (Fazio et al, 1986; Bargh et al 1996; Hermans et al 1994; De Houwer et al, 1998b). One

explanation for this was the location of the words. It was necessary to present one word above the other in these experiments because of the overlap in presentation on the shorter SOA's (-150ms, 0ms, 150ms). But in the previous experiments words were presented in exactly the same place on the screen. Hermans et al (2001) suggest that the location could influence affective priming, especially if 300ms is near the end of the time course and the effect is therefore already weaker.

To test this hypothesis they ran a third experiment. The evaluative decision task from experiment 1 was employed. Half the trials used centred presentation where prime and target were presented in the same place, and half used an un-centred presentation where prime and target were presented above one another as in experiment 2. SOA was set at 300ms. Results showed that affectively congruent trials were responded to more quickly than affectively incongruent trials in the centred condition, but that this effect did not hold for the un-centred condition.

Hermans et al (2001) concluded that the absence of the priming effect at the SOA of 300ms was caused by the way the stimuli were presented. Because the priming effect was reduced by the presentation mode at 300ms but not at the shorter SOA's of 150ms and 0ms, it suggests that priming effects at 300ms are weaker than priming effects at the shorter SOA's. This means that 300ms must be near the end of the affective priming activation curve.

Hermans et al's (2001) results provide a more detailed understanding of the time course of affective priming and therefore automatic evaluation. Their findings suggest that automatic evaluation occurs immediately at an SOA of 0ms and peaks at an SOA of 150ms. The effect seems to be weaker at an SOA of 300ms and will only be apparent under certain circumstances. Interestingly the time course is similar in both evaluative decision and pronunciation tasks suggesting that if different

mechanisms are in use then they have a similar temporal course. This finding suggests that in the studies by De Houwer et al (2001) and De Houwer and Randell (2004) it is not the increased temporal course that allows affective priming to occur, but that it is indeed the increased amount of semantic encoding. So once again there is support for the role of semantics in affective priming.

Summary and Conclusions

This review has shown that evaluation can be automatic, in the sense that it is unintentional, and has been found in studies of affective priming, and affective versions of the Simon paradigm. In some of these studies the primes have been task relevant (Bargh et al 1992; De Houwer et al, 2001), and so whilst processing of the valence is unintentional, attention has been drawn to the prime and processing of other features is required. So it is therefore less remarkable that valence is determined, especially if semantic features such as word meaning are task relevant as it seems likely that the valence of the word is deeply connected to its meaning. However, affective priming has been demonstrated numerous times with primes that are not task relevant; so it seems that valence is processed unintentionally when there is no need to attend to, or process, the prime in any other way, and even when the prime is subliminally presented (Klinger et al, 2000). These studies have suggested that most stimuli are automatically evaluated, and have clarified that the time course of this phenomenon is rapid; it has immediate onset and has weakened by 300ms.

The affective priming paradigm produced affective priming effects in affective decision tasks, lexical decision tasks, and pronunciation tasks. Finding affective priming in the pronunciation task sparked important questions into the mechanisms

underlying the effect, as it supports semantic spreading activation mechanisms and rules out response competition effects in that task. However, a difficulty in reproducing effects in the pronunciation task led to suspicions that automatic evaluation was therefore not as robust as first claimed. Thus the mechanisms behind the affective priming effect became even more important to elucidate as they provide insight into when and how automatic evaluation occurs, and how it affects a subsequent response. Although three mechanisms for the affective priming effect have been proposed (response competition, spreading activation, and distributed memory model), it is still unclear which ones are operating. It is likely that different paradigms elicit affective priming through different mechanisms. It may be the case that some affective priming paradigms might dampen the influence of the prime on the target and therefore our ability to tell if the prime has been automatically processed. Therefore although the affective priming paradigm is a popular and useful tool in the research on automatic evaluation, null results cannot confirm that evaluation of the prime has not taken place. Thus it is important that other paradigms demonstrate automatic evaluation. An affective version of the Simon paradigm has also revealed automatic evaluation effects confirming the findings from the affective priming literature.

In conclusion, research has demonstrated that evaluation of a stimulus' valence can be rapid, unintentional and automatic. It has been claimed that these evaluations are useful because they predispose individuals to behave in an appropriate manner i.e. to approach or to avoid the stimulus (Chen and Bargh, 1999). This idea is consistent with findings that show that colour naming latencies are longer when the word is negative in valence and socially relevant than positive or negative in valence and not socially relevant (Pratto and John, 1991). Thus negative social information

automatically draws attention away from current demands and towards potentially threatening items. In addition Dijksterhuis and Aarts (2003) demonstrated that that the detection of the presence, and the valence, of subliminally presented negative words is more accurate than positive words or neutral words, which shows preferential detection of negative emotional stimuli. This would be useful if it readies the organism to execute an appropriate response. A few studies have directly demonstrated a link between evaluation and approach/avoid behaviour (Solarz, 1960; Chen and Bargh, 1999; Duckworth et al, 2002; De Houwer et al, 2001; Rotteveel and Phaf, 2004). These studies will be reviewed in the following chapters. In Chapter 4 we look at the link between automatic evaluation and approaching and avoiding, but first, in Chapter 3, we examine the link between explicit evaluation and approach/avoid behaviour.

Chapter 3.

Explicit evaluation and the approach/avoid response.

As early as 1960, Solarz established a connection between evaluation and approach–avoid behaviours. Solarz's experiment involved participants moving a stage, that presented a word, towards or away from themselves with a hand lever. Before the main experiment each participant was given a list of ten words and asked to think about the meaning of each word. The words were presented as five pairs. Four of these pairs consisted of a positive word and a negative word, such as sweet and sour, or kind and cruel. The fifth pair consisted of words relating to distance or place, such as near and far, or here and there. Participants were then told that there was a prearranged pattern of correct moves for the words and that they must learn. Each word in that participants list was then presented on the stage and participants had to respond by moving the stage, and so the word, towards or away from themselves. The experimenter would then reveal whether the movement was correct or incorrect. The pattern of correct moves required five toward movements and five away movements, and importantly participants completed toward and away movements for both positive and negative words. Participants continued until they produced two errorless runs of all ten words. The times taken to initiate a response, and to move the lever, were recorded.

Solarz (1960) found that participants were faster to initiate a compatible movement, decreasing the distance between the self and the word by pulling for positive words, and increasing the distance between the self and the word by pushing for negative words, than an incompatible movement, decreasing the distance between the self and the word by pulling for negative words, and increasing the distance

between the self and the word by pushing for positive words. This is consistent with the hypothesis that evaluating a stimulus as good or bad will then predispose an individual to behave in a manner congruent with the evaluation.

More recently Chen and Bargh (1999) ran a similar lever based experiment. Participants were presented with 92 valenced words. Those in the congruent condition were instructed to push the lever away from them if they disliked the word, and to pull the lever towards them if they liked the word. Those in the incongruent condition were given the opposite instructions. The time between the word appearing and the lever being moved 10 degrees in the correct direction was recorded. In this experiment the push or pull movement of the lever did not affect the word's position by moving it closer or further away, as in Solarz (1960). Instead the word remained stationary.

Chen and Bargh (1999) found that participants in the congruent condition had faster responses than participants in the incongruent condition. This difference was considerable; mean reaction times for the congruent condition were 1,683ms, whereas for the incongruent condition they were 1,950ms (267ms difference). This shows a similar compatibility effect to Solarz (1960). Chen and Bargh concluded that evaluating a stimulus predisposed participants to behave in an appropriate manner – approach pleasant items (using a pulling motion) and avoid unpleasant items (using a pushing motion). They embedded this into an evolutionary model arguing that this predisposition to respond following evaluation has an adaptive benefit enabling an organism to prepare effective responses under strict time constraints.

Additionally, Chen and Bargh (1999) found that responses were quicker after negatively valenced words than after positively valenced words. This provides evidence of a greater vigilance towards negative stimuli in the environment. This

vigilance has also been demonstrated by Pratto and John (1991). They showed that naming the colour of words took longer if the word was undesirable than if it was desirable. Their results also showed increased incidental learning for the unpleasant words than the pleasant words, supporting a perceptual vigilance hypothesis rather than a perceptual defense hypothesis. Thus, the authors claimed that attention had been caught by the undesirable meaning of the word. It makes sense that noticing undesirable events (e.g. a predator) is more important than noticing desirable events (e.g. a mate), and this fits nicely into the evolutionary argument for a link between evaluation and behaviour.

Thus, Chen and Bargh (1999) demonstrated a link between conscious evaluation and approach-avoid motor responses. This link occurred regardless of attitude strength towards the valenced words. I sought to create a similar explicit evaluation paradigm suitable for patient testing. Although a clever manipulation for examining approach and avoid responses in healthy controls, Chen and Bargh's paradigm is not suitable for patient testing. Their task used centrally presented stimuli, which does not allow the powerful comparison of ipsi-lateral and contra-lateral processing essential for patients with unilateral damage. In my paradigm the presentation of the valenced stimuli was lateralized on a touch screen monitor. As well as creating an approach/avoid paradigm suitable for patients, the lateralized presentation also allows us to look at Davidson, Ekman, Saron, Senulis, and Friesen's (1990) theory that positive and negative emotions, and approach and avoid tendencies, are lateralized across the frontal lobes. Davidson et al claim that positive emotional responses and approach tendencies are located in the left frontal lobe, and negative emotional responses and avoid tendencies are located in the right frontal lobe (this theory will be explored in more detail in Chapter 6). In my study, then, we can look at whether

approaching a positive item on the right is responded to any more quickly than approaching a positive item on the left, and whether avoiding a negative item on the left is responded to any more quickly than avoiding a negative item on the right.

Experiment 1

Method

Participants. Twenty undergraduates (sixteen female) participated for course credit. All were right handed, native English speakers, had normal vision, normal hearing, and no neurological problems. All gave informed consent and were debriefed after the experiment.

Stimuli. Picture stimuli were taken from the International Affective Picture System (Lang, Bradley, and Cuthbert, 1999). There were 80 picture stimuli, 40 pleasant and 40 unpleasant. Pleasant pictures had an average rating of 7, and unpleasant pictures had an average rating of 3.3 (on Lang's valence scale 1-9). Average arousal ratings for pleasant and unpleasant pictures were 4.9 and 5.1 respectively (on Lang et al's arousal scale 1-9), and did not differ significantly. Examples of the pleasant pictures are babies, beautiful scenery, and food. Examples of the unpleasant pictures are starving children, horrific injuries, and insects. Pictures were 8x8cm in size.

The 92 word stimuli, 46 pleasant and 46 unpleasant, were taken from Fazio (1986). These words had been rated for valence by participants in Fazio's study. Unpleasant words had an average rating of -2.5 and pleasant words an average rating of 2.5 on Fazio's scale from –5 (extremely unpleasant) to 5 (extremely pleasant). No ratings for arousal were given. The words Reagan, Russia, and fraternity were

removed because it was felt that they were out of date and/or would not be relevant to current British undergraduates. They were replaced by aloof, derelict, and corridor respectively, which had near identical ratings, from the International Affective Word System (Lang et al, 1999). Examples of pleasant words include pizza, aquarium, and sunshine. Examples of unpleasant words include knives, death, and cockroach. Words were presented in lower case letters, Geneva font, size 28, and in bold. The neutral stimulus was a grey square. This was 8cm x 8cm.

Stimuli were presented on an Elo touch systems monitor controlled by an Apple Macintosh computer. Stimuli were presented on either the left side or right side of the screen 232mm from the centre. Participants were seated approximately 50cm from the screen.

Design. The task employed in this experiment led to a mixed design with within-subjects factors of Side (Left/Right), Valence (Pleasant/Unpleasant), Task (Congruent = approach pleasant items or avoid unpleasant items / Incongruent = approach unpleasant items or avoid pleasant items) and Stimulus Type (Word/Picture), and between subjects factors of Order (the order in which they completed the Tasks e.g. Congruent then Incongruent). The dependent variable was Total Time to release button and touch the screen.

Procedure. Participants were seated in front of a touch screen monitor in the experimental room. On the table between them and the monitor was an x-keys keypad. There was a small speaker on each side of the computer monitor.

Each trial proceeded as follows: A fixation-cross appeared in the centre of the screen. The participant started the trial by pressing the large key in the centre of the keypad with their right hand and keeping the key depressed. After 500ms the valenced stimulus (Picture or Word) appeared on one side of the screen and the

neutral stimulus (a grey square) appeared on the other. There was a delay of 300ms between the onset of the visual stimuli and a tone from the speakers indicating that the participant could now respond. This delay and tone were included to try to ensure that participants had judged the valence and decided what the response would be before letting go of the key and making the movement. The delay of 300ms was chosen to be long enough for the participant to have started to make the judgment but short enough to ensure the initial reaction to the valenced stimuli had not yet been overridden. The tone was a beep of 220 Hz and was 38ms in duration. If the participant released before the tone then a response on the screen would not be allowed. The participant would then have to press and release the key again before responding. This led to very long reaction times that were automatically discarded during the iterative trimming of the data.

In the Congruent task the participants were instructed to let go of the key, reach toward the screen with their right hand and touch the Picture/Word if they liked it (an Approach movement), and to touch the square if they did not like the Picture/Word (an Avoid movement). In the Incongruent task participants were instructed to touch the Picture/Word if they did not like it (an Approach movement) and touch the square if they did like the Picture/Word (an Avoid movement). When a response was made the Picture/Word and square disappeared and 750ms later the fixation cross for the next trial appeared. No references to approaching or avoiding were made in the instructions. See Figure 3.1.

Each participant completed 4 blocks: Congruent Pictures, Incongruent Pictures, Congruent Words, Incongruent Words. In a block of trials, each stimulus was presented twice – once on each side. This led to 160 trials for each Picture block and 184 trials for each Word block. Overall there were 688 trials (2 Picture blocks

consisting of 160 trials each, and two Word blocks consisting of 184 trials each). Each block took between 5 and 10 minutes to complete.

The between subjects factor of Order was counterbalanced across participants; Half of the participants (n = 10) did both Picture and Word blocks following Congruent instructions and then repeated them both following Incongruent instructions (Congruent Pictures, Congruent Words, Incongruent Pictures, Incongruent Words (n = 5), OR Congruent Words, Congruent Pictures, Incongruent Words, Incongruent Pictures (n = 5)). The remaining half (n = 10) completed both Picture and Word blocks following Incongruent instructions and then repeated them with Congruent instructions (Incongruent Pictures, Incongruent Words, Congruent Pictures, Congruent Words (n = 5), OR Incongruent Words, Incongruent Pictures, Congruent Words, Congruent Pictures (n = 5)).

Before the experiment began participants were asked to read through the instructions, ask any questions they may have, and then sign the consent form. The experimenter demonstrated the procedure, and then the participant performed approximately 10 to 20 practice trials until it was deemed by the experimenter that they had mastered the instructions.

Following the main experiment there was an additional rating task. Participants were presented with an excel workbook containing each word that they had seen in the main experiment word task. They were asked to enter their rating for each word on a scale ranging from 1-7, 1 being very unpleasant and 7 being very pleasant. These ratings were then used in an additional analysis examining the congruency effect for words evoking strong and weak attitudes.

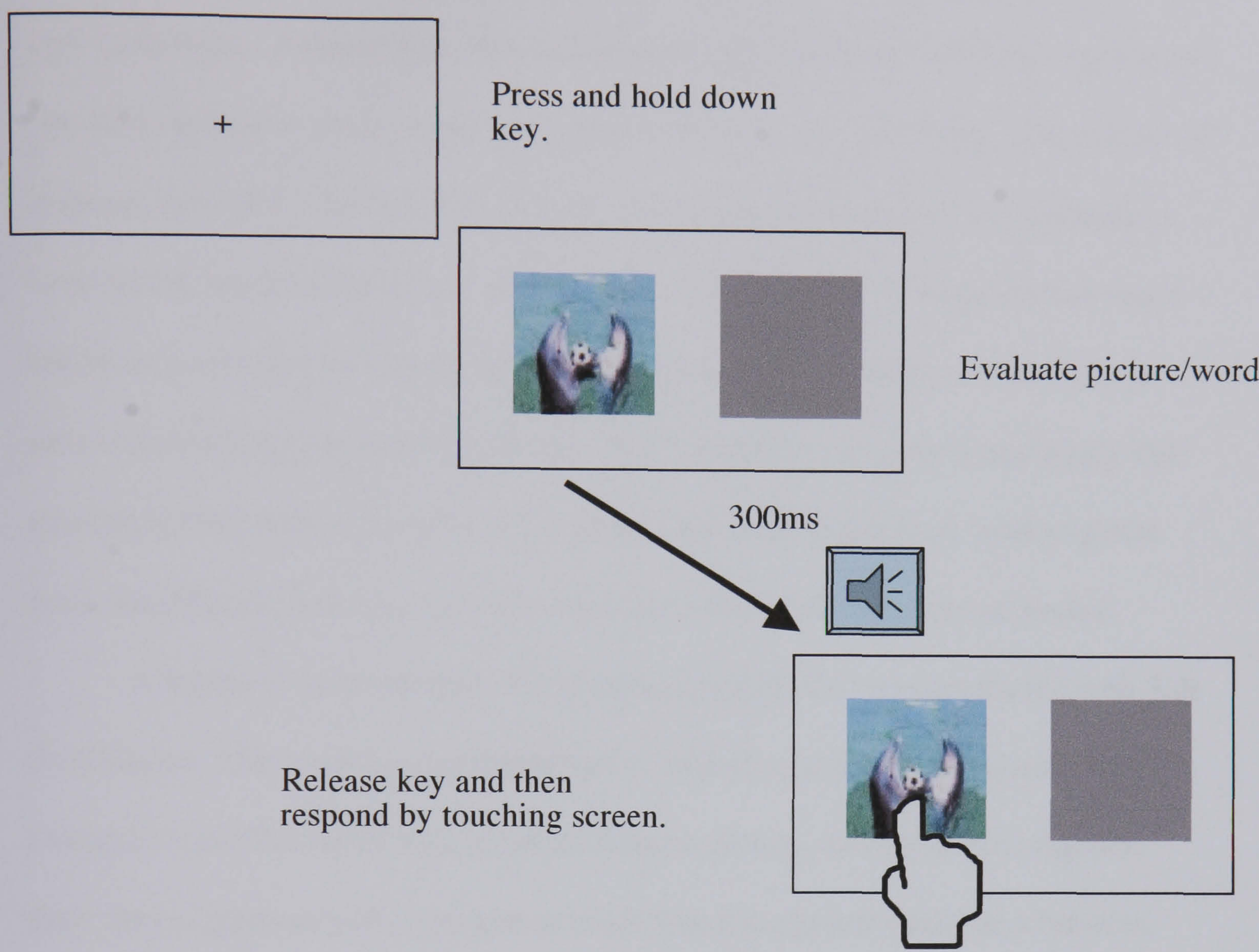

Figure 3.1. A diagram depicting the sequence of events in the explicit evaluation experiment. The picture and word tasks are the same. The task in this experiment is to evaluate the picture or word and then respond based on the rules of the experimental condition. In the Congruent condition participants touch pleasant items and avoid (by touching the square) unpleasant items. In the Incongruent condition this is reversed.

Results

Prior to analysis, Response Time (RT) distributions were iteratively trimmed to include scores within 3 standard deviations of the mean, for each condition and for each participant. Release time (the time taken to release the key) and movement time (the time taken to reach towards and touch the screen) were recorded. The analysis of response time (RT) was based on the total time taken to release the key and make a response by touching the screen. This avoided the possibility of tradeoffs that might not be seen if release or movement time were analyzed separately: for example, a slow reaction time that incorporated movement planning and a correspondingly fast movement time (tables containing the release time, movement time, total response time, and relevant statistics, for each experiment can be found in the appendix).

A repeated measures analysis of variance (ANOVA) was conducted with Side (Left/Right), Valence (Pleasant/Unpleasant), Task (Congruent/Incongruent), and Stimulus Type (Picture/Word) as within subjects factors, and Order (Incongruent trials then Congruent trials/ Congruent trials then Incongruent trials) as a between subjects factor.

The analysis revealed a significant main effect of Task (Figure 3.2). As predicted the Congruent condition yielded faster reaction times than the Incongruent condition (Congruent M = 893.9ms, SD = 169.6, Incongruent M = 1004ms, SD = 269.4), $F(1,18) = 8.86$, $p < .01$. Participants were faster to approach the pleasant stimuli and avoid the unpleasant stimuli than they were to approach the unpleasant stimuli and avoid the pleasant stimuli.

Figure 3.2. Mean Response Times in milliseconds for Congruent and Incongruent responses.

There was a significant interaction of Valence by Task, $F(1,18) = 8.75$, $p < .01$. This simply shows that participants were faster to approach stimuli than avoid them, Approach M = 924, SD = 238, Avoid M = 974 , SD = 223.

There was a significant interaction of Order by Task, so that RTs were slower with the first set of instructions (Congruent or Incongruent) than the second, $F(1,18) = 19.30$, $p < .001$, suggesting improvement with practice.

There was a main effect of Stimulus Type, $F(1,18) = 8.93$, $p < .01$. Participants were faster to respond to Words than to Pictures (Word M = 906.9ms, SD = 203.4, Picture M = 990ms, SD = 250). There were no other significant effects involving Stimulus Type, suggesting that my findings are comparable for both Words and Pictures.

Lastly the interaction of Side by Valence by Task, which would show any lateralization effects, was not significant $F(1,18) = 1.89$, $p = .187$. Table 1. shows that participants are descriptively faster to approach pleasant items on the right than the left, and to avoid than unpleasant items on the right than on the left.

Table 1.

Means and Standard Deviations (in brackets) for Response Times (in milliseconds) in Experiment 1 for the interaction of Side by Valence by Task.

	Pleasant		Unpleasant	
	Left	Right	Left	Right
Congruent	**861 (169.3)**	**853.3 (153.1)**	926.1 (172.1)	935.3 (173)
Incongruent	1004.9 (259.5)	1028.9 (259.8)	**1011 (288.1)**	**971.1 (276.2)**

An additional analysis was conducted for the word stimuli to examine the congruency effect for words evoking strong and weak attitudes. Response times were calculated as in the main analysis. In this analysis the factor of Attitude Strength (Weak/Strong) was added and the factor of Stimulus Type (Picture/Word) was removed. Attitude Strength was calculated by assigning the words rated as 1, 2, 6, and 7 as Strong and the words rated as 3, 4, and 5 as Weak. The analysis revealed that the interaction of Task by Attitude Strength was not significant, $F(1,18) = 1.17$, $p = .292$. The congruency effect was large for both Strong and Weak attitudes. There was no evidence that the congruency effect only occurs for words evoking strong attitudes. In fact the congruency effect was slightly larger for the Weak attitudes than the Strong (Strong Attitude congruency effect = 108ms, Weak Attitude congruency effect = 142ms). There was a main effect of Attitude Strength $F(1,18) = 49.84$, $p < .001$ showing that response times to words evoking Strong Attitudes were faster than to words evoking Weak attitudes (Strong M = 878.9 SD = 197.7, Weak M = 999.8 SD = 300.5). This is hardly surprising as the criteria for Strong and Weak attitudes was speed of response in Chen and Bargh's (1999) study. This shows that speed of response does correspond to strength of attitude measured using a rating scale. As expected this analysis also revealed a significant main effect of Task $F(1,18) = 12.08$, $p < .01$, and a significant interaction of Task by Order $F(1,18) = 18.2$, $p < .001$, as in the main analysis for the Pictures and Words.

Discussion

Experiment 1 showed a large congruency effect in which participants were faster to approach pleasant and avoid unpleasant items and were relatively slower to

avoid pleasant and approach unpleasant items. The response times in these two conditions differed by 95ms demonstrating the strength of the approach/avoid preference.

It is possible that the congruency effect in this experiment is caused by a phenomenon called polarity. This occurs when a positive response to a positive item is quicker than a positive response to a negative item, and similarly a negative response to a negative item is quicker than a negative response to a positive item. Specifically, in this experiment the positive response would be "touch the valenced item" and the negative response would be "don't touch the valenced item", so touching the positive item matches in polarity and is therefore quicker than touching a negative item. So the effects could either be due to approach and avoidance congruency effects, or to polarity. In Chapter 5 I reverse the congruency effects by reversing the consequence of responding whilst keeping the response consistent. Thus the polarity explanation is ruled out for this series of experiments.

Experiment 1 showed that the congruency effect occurred regardless of attitude strength towards the words. This is consistent with Chen and Bargh's (1999) results who found congruency effects with all objects regardless of attitude strength, and once again goes against Fazio (1986) who, recall from Chapter 2, argued that the congruency effect would be modified by attitude strength. It seems that when asked to evaluate an object a participant will then have a predisposition to approach or avoid it based on that evaluation regardless of whether the object is strongly or weakly valenced.

In addition my paradigm allowed us to look at lateralization effects. Davidson et al's (1990) lateralization theory would predict faster responses to approach pleasant items presented on the right than on the left, and faster responses to avoid unpleasant

items presented on the left than on the right. When examining the means in detail, see Table 2, we do see a small difference in this predicted direction, although the experimental task provides a confound –right handed participants were faster to approach items on the right and avoid items on the left – and this might have biased the data in favour of Davidson et al's hypothesis. Since completion of these studies the possibility of getting right-handed participants to complete the task with their left hands, to balance out the confound and allow investigation of lateralization on this task, has been considered. These experiments are planned for the near future. It is important to use right-handed participants because cerebral organization is more consistent in right-handed people than left (Rasmussen and Milner, 1975). Left-handers may have the same cerebral asymmetry as right-handers but there is a greater chance of them having an anomalous pattern (Kim et al, 1993). Thus, confining the experiments to right-handers controls for hemispheric dominance and allows a clearer investigation of lateralization to take place (Knecht et al, 2000).

In Experiment 1 a large and robust congruency effect was successfully demonstrated using a paradigm that was specially designed to be suitable for patient testing. The results of this experiment suggested that the approach/avoid response following evaluation is automatically activated, so it is interesting to examine how it compares to other automatic responses, such as the Stroop and Simon effects. Experiment 2 examined the time-course of the congruency effect and whether it, as an automatic process, might be actively and consciously suppressed given time. To explore these questions the experimental design was modified slightly, and a variable delay was introduced, for Experiment 2.

Experiment 2

In Experiment 2 the time-course of the congruency effect demonstrated in Experiment 1 was examined. This is important because methodologically it is critical to determine the point at which the effect is strongest, and also when it has decayed, in order to design a paradigm that will produce large effects, and to avoid inadvertently creating a paradigm that masks the effects. Additionally, it is interesting to compare the time course of the congruency effect to that of the automatic evaluation effect, and to other automatic processes such as Stroop effects, Simon effects, and affordance compatibility effects.

In the Stroop task (Stroop, 1935) the response time taken to name the colour of the ink that a word is printed in is affected by the irrelevant feature of the words meaning; for example the word *blue* printed in blue ink will be named correctly faster than the word *red* printed in blue ink. Both words have the same correct answer, blue, but the meaning of the word affects reaction time, showing that meaning has been processed automatically. This effect occurs rapidly and has decayed by around 400ms (Kornblum, Stevens, Whipple, and Requin, 1999).

Similarly, in the Simon task (Simon and Small, 1969) an irrelevant feature affects response time to a relevant feature. For example, a stimulus presented on the right will be responded to faster if the correct response demands a right-sided response than if it demands a left-sided response. The irrelevant feature of stimulus location exerts an effect on the response. This effect also occurs rapidly, and has decayed by 200ms (Kornblum Stevens, Whipple, and Requin, 1999; Hommel, 1994).

In contrast, the time course of the compatibility effect of affordances shows a different pattern. An affordance is a property of an object that elicits a predisposition

to respond in a certain manner. For example, a frying pan with a handle sticking out would afford the response, or action, of reaching out with the nearest hand and picking it up. Responses are faster and more accurate when they are compatible with affordances than when they are incompatible. Tucker and Ellis (1998) showed that compatibility effects can occur between objects whose affordances are irrelevant to the requested response. They presented objects that were either the right way up or upside down with their handles pointed to the left or right side of space. The requested response was based on the orientation of the object as a whole - is it the right way up or up side down? But they found compatibility effects between the side the handle is on and the side of the response, despite the requested response being linked to the orientation of the whole object and not to the orientation of the handle.

Phillips and Ward (2002) investigated the time course of this phenomenon and showed that the compatibility effects develop gradually and are relatively long-lasting. Specifically, the compatibility effects start to emerge at 400ms and continue to grow through 800ms and increase further by 1200ms. This is in contrast to other automatic behaviours such as the Simon and Stroop effects.

The automatic evaluation effect, shown in the affective priming studies that were discussed in detail in Chapter 2, has a time-course that is similar to the Stroop and Simon effects, as it occurs immediately and has decayed by 300ms (Hermans, De Houwer, and Eelen, 2001). The prediction is that the congruency effect occurs and decays fairly rapidly, like the pattern of the time-course of the automatic evaluation effect, but on a slightly later time scale to account for the explicit evaluation nature of the judgment in my task. This would be similar to the time-course of the Stroop and Simon effects, and would contrast with the time-course of affordance compatibility effects.

Experiment 2 was designed to address this question. In Experiment 2, then, the delay between stimulus presentation and the auditory go signal, that indicated the participant could respond, was varied.

Method

Participants. Twenty Four undergraduates (Twenty two female) participated for course credit. All were right handed, native English speakers, had normal vision, normal hearing, and no neurological problems. All gave informed consent and were debriefed after the experiment.

Stimuli. Stimuli were identical to those used in the previous Experiment.

Design. The design was identical to the previous Experiment with the added within subjects factor of Delay (Short/Medium/Long).

Procedure. The procedure was the same as in the previous experiment with one exception. In this experiment there was a variable delay of 300ms, 650ms, or 1000ms between the onset of the visual stimuli and the tone from the speaker indicating that the participant could now respond. These delays were labeled Short, Medium, and Long respectively. The delays occurred in a random order to ensure that the participants could not predict what would happen on each trial. Each of the three delays occurred an equal amount of times.

Results

Prior to analysis, Response Time (RT) distributions were iteratively trimmed to include scores within 3 standard deviations of the mean, for each condition and for each participant. Response times were calculated as in the previous experiment. A repeated measures analysis of variance (ANOVA) was conducted with Side

(Left/Right), Valence (Pleasant/Unpleasant), Task (Congruent/Incongruent), Delay (Short/Medium/Long) and Stimulus Type (Picture/Word) as within subjects factors, and Order (Incongruent trials then Congruent trials/ Congruent trials then Incongruent trials) as a between subjects factor.

The important interaction of Task by Delay was not significant $F(2,44) = 2.37$, $p = .105$. T-tests revealed that the size of the congruency effect at the Short delay was not significantly different from the congruency effects at the Medium, $t(46) = .865$, $p = .391$, or Long delays, $t(46) = .948$, $p = .348$. Likewise the difference between Medium versus Long delay was not significant $t(46) = .176$, $p = .861$. But descriptively we can see that the congruency effect was much larger for the Short condition than for the Medium and Longer conditions; see Figure 3.3.

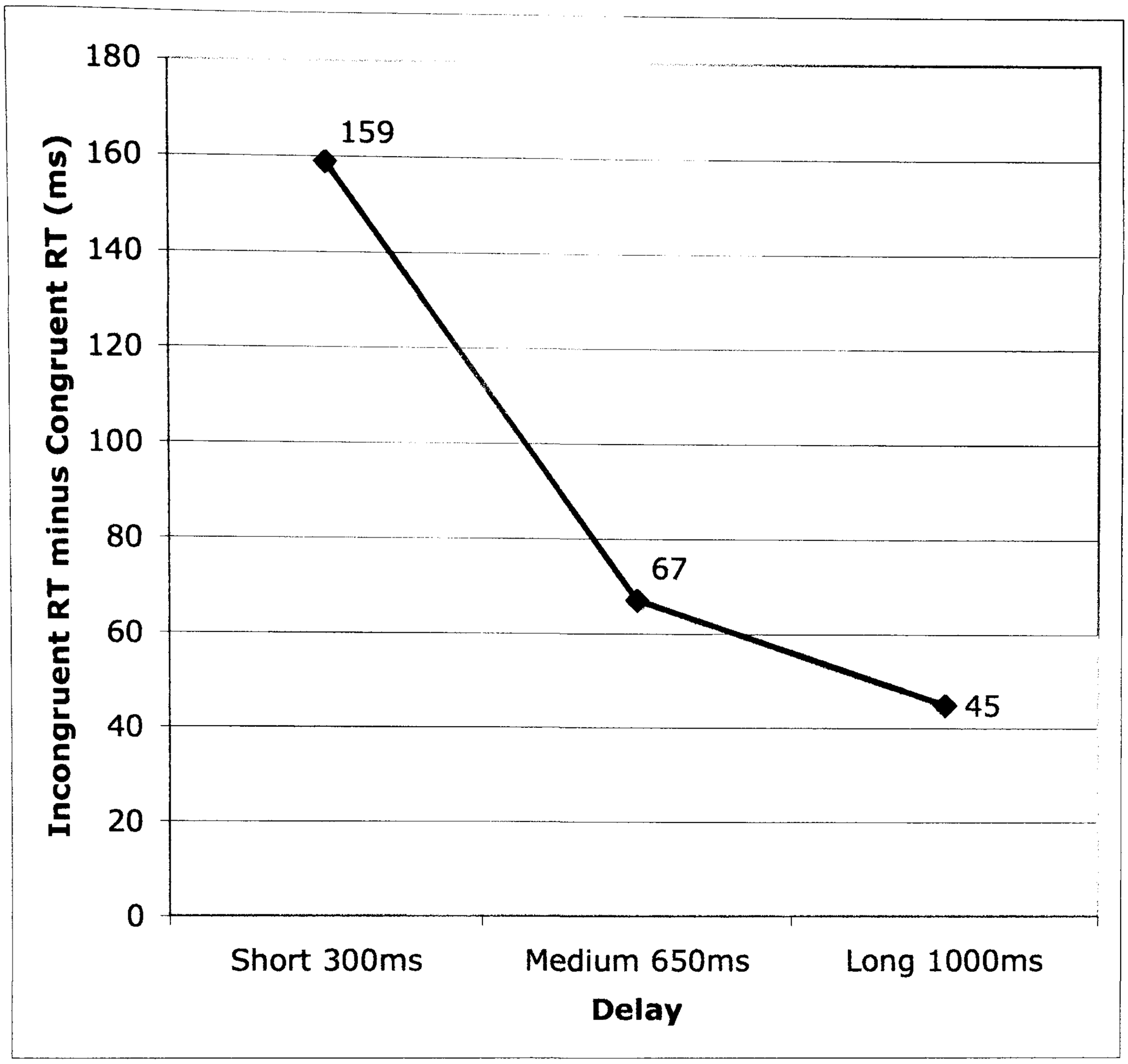

Figure 3.3. Congruency effect at each Delay.

There were also a number of other significant effects arising from the ANOVA.

There was an Interaction of Task by Order $F(1,22) = 13.39$, $p < .01$, showing improvement with practice over the blocks.

There was a main effect of Valence $F(1,22) = 7.62$, $p = .011$, showing that participants were faster to respond to the pleasant items than the unpleasant items (Pleasant M= 975 SD = 407.9, Unpleasant M = 1046, SD = 597.8).

There was a main effect of Delay, $F(2,44) = 24.43$, $p < .001$, showing that response times were inversely proportional to Delay (Short M = 1108.7 SD = 478, Medium M = 965.4 SD = 524.4, Long M = 957.5 SD = 521.8).

There was a main effect of Stimulus Type $F(1,22) = 5.038$, $p < .05$, showing that participants were faster to respond to the Words than to the Pictures (Word M = 947.3 SD = 343, Picture M = 1073.8 SD = 632.9).

Lastly, there was a significant interaction of Valence by Stimulus Type $F(1,22) = 4.32$, $p = .05$, showing that for the picture task there was a large difference between response times for pleasant and unpleasant stimuli (Pleasant M = 1008.0 Unpleasant M = 1139.5), but for the word task the difference was smaller (Pleasant M = 942.0, Unpleasant M = 952.7).

The main effect of Task was not significant $F(1,22) = 2.16$, $p = .155$, although the Congruent conditions were descriptively faster than the Incongruent conditions, (Congruent M = 965.6 SD = 450.1, Incongruent M = 1056 SD = 565.4).

Discussion

Experiment 1 showed that a large and robust congruency effect was demonstrated on my paradigm that was specially designed to be suitable for patient testing, as well as for healthy controls. Experiment 2 investigated the time course of this congruency effect. The delay between stimulus presentation and an auditory go signal, indicating that the participant could respond, was varied. This demonstrated that the congruency effect occurs and decays rapidly. As shown in Figure 3.2 the congruency effect has hit a peak of 159ms with a 300ms delay. The size of the congruency effect then decays quite quickly; when participants are prevented from responding for 650ms the congruency effect has reduced to 67ms, and by 1000ms it

has reduced further to 45ms, although these differences are not statistically significant from one another. The decay in the congruency effect over time is in line with the evolutionary argument that the predisposition to approach or avoid, that follows evaluation, exists because it confers an evolutionary advantage by ensuring the individual can respond both rapidly and appropriately. When the participant is prevented from responding immediately the congruency effect reduces which shows that it can be suppressed. It is still at a reasonable size, and in the expected direction, and so appears to be a fairly strong predisposition that is not extinguished easily. In this experiment 300ms was the shortest delay and it is possible that the congruency effect would be even larger with no delay.

It is possible that the reduction in the congruency effect is due to a fan effect where the size reduces because the overall response time for each delay condition also reduces. This has been checked and we see that the size of the congruency effect is 159ms at the shorter delay with an overall response time of 1109ms, thus the congruency effect is 14% of the overall mean, at the medium delay it is only 7% (67ms congruency effect/965ms overall mean), and at the long delay it is 5% of the overall mean (45ms congruency effect/958ms). Thus it seems that the reduction in the size of the congruency effect is not due to a fan effect.

The pattern of this time course, with its rapid onset and decay, corresponds to the time course of the automatic evaluation effect. Recall that in an affective priming task Hermans et al (2001) showed that affective congruence facilitated responses in trials with 0ms and 150ms delays, but not in trials with 300ms, and 1000ms delays. The automatic evaluation effect occurs immediately and has decayed by 300ms. This pattern is therefore a similar pattern to the one I have demonstrated on my explicit

evaluation approach/avoid task. It occurs earlier, as you would imagine, for the automatic evaluation effect than for the explicit evaluation in my study.

My demonstration of the time-course of the congruency effect contrasts with the time-course of compatibility effects of affordances, but fits in with the time-course of other automatic behaviours, such as Stroop and Simon effects. Importantly, the temporal pattern of the explicit evaluation congruency effect mirrors that of the automatic evaluation effect, although as expected the pattern occurs slightly later. This is consistent with Williams et al (2004) Event Related Potential (ERP) data showing rapid perception of fear stimuli for non-conscious processing, and slightly later processing of consciously perceived stimuli that increases rapidly and then dies away.

Williams et al (2004) investigated the time-course of fear perception. Williams et al backwardly masked faces expressing fearful and neutral expressions. First they established a detection threshold (where participants cannot detect whether a face has been presented above chance accuracy using forced choice), a discrimination threshold (where participants cannot discriminate between emotional expressions of a presented face above chance accuracy using forced choice), and a suprathreshold (where participants were consciously able to discriminate between facial expressions above chance accuracy). The detection threshold was set at 10ms, the discrimination threshold set at 30ms, and the suprathreshold at 170ms. Participants were then presented with the backwardly masked faces at the three thresholds and measures of ERP were recorded to coincide with the stimulus presentation. Results showed that non-conscious fear perception elicited greater responses for the N2 component at 200ms post-stimulus, and faster P1 responses within 100ms, relative to neutral stimuli. Beyond 200ms there was a decline in

activity. The conscious fear perception was distinguished by a prominent N4 peaking around 400ms.

Williams et al (2004) state that the early ERP components (N2 and P1) generated in the first 200ms reflect activity in the thalamic-cortical circuit, and that these early ERP's are enhanced by input from the brainstem enabling rapid and crude sensory alerting functions. The transition from non-conscious to conscious perception occurs at around 200ms with the comparison of incoming and stored information Gray (1995). The N4 peak at 400ms for conscious processing is consistent with the engagement of cortical networks associated with conceptual knowledge of the stimulus and emotion. There is also evidence from Magnetoencephalography (MEG) studies (Strait et al, 1999) that prefrontal activity commences around 300ms for the perception of fear expressions. The N4 peak demonstrated by Williams et al (2004) may therefore provide a temporal indication of the slower cortico-amygdala pathway for fear processing (Ledoux, 1998).

Williams et al (2004) study is therefore consistent with both Hermans, De Houwer and Eelen (2001) time course of the automatic evaluation effect and my demonstration of the time course of the congruency effect following explicit evaluation. Hermans et al show that the time course of the automatic evaluation effect occurs immediately is strong at 150ms and has decayed by 300ms. This fits with Williams et al's ERP data showing activity for non-conscious fear processing occurring rapidly and dying off by 200ms. I have shown that the congruency effect – reflecting the automatic predisposition to approach or avoid following explicit evaluation – occurs rapidly, peaking at 300ms, and dies down over a longer period of time. This reflects Williams et al's results for the conscious processing of fear. They show that this begins at around 200ms and peaks at around 400ms, which corresponds

well with my 300ms peak. Thus, two different lines of research have produced similar time-course results for the responses to valenced stimuli.

The time-course demonstrated in my experiment is consistent with the argument that the predisposition to approach or avoid exists because it confers an evolutionary advantage by ensuring the individual can respond appropriately under tight time constraints.

Methodologically the detailed mapping of the time course is important in designing experiments with delays that will produce the largest effects in healthy controls to provide a basis for comparison for the patients. Additionally, it might explain any null effects that might be found in future tasks.

Chapter 4

Automatic evaluation and the approach/avoid response.

The previous chapter demonstrated a large congruency effect on an explicit-evaluation task and examined the time-course of this effect. This chapter focuses on whether congruency effects can be found on an automatic-evaluation version of the task.

Small congruency effects have been found after automatic evaluation in a few studies. The first to demonstrate such an effect were Chen and Bargh (1999). In Chen and Bargh (Expt 2) participants were presented with valenced words, but no instruction to evaluate them was given. Instead, participants were instructed to always pull a lever towards them, or always push a lever away from them, upon presentation of the word. A random delay was added between start of the trial and word presentation to reduce the possibility that participants would anticipate the word. Half way through the trials the instructions were reversed; participants who had pushed the lever now pulled, and vice versa. Because participants had not evaluated the words their valence was determined using the results of Bargh, Chaiken, Govender, and Pratto's (1992) norming study.

Results showed a main effect of congruence with faster responses in congruent trials (pulling the lever when a positive word appeared, pushing the lever when a negative word appeared) than in incongruent trials (pushing when positive words appeared, pulling when negative words appeared). This difference was much smaller than when participants intended to evaluate the words; mean reaction times were 679ms for the congruent condition, and 688ms for the incongruent condition (9ms difference).

Thus, Chen and Bargh (1999) show that automatic evaluations, as well as intended evaluations, predispose individuals to approach the stimulus if it is good and to avoid the stimulus if it is bad. Chen and Bargh explain that this finding is consistent with the idea that automatic evaluation exists to prepare the individual to respond in an appropriate manner to events that are not in the focus of conscious attention. They describe how relying solely on slow conscious processes to evaluate and react to stimuli would not be adaptive. Instead, having a backup system that rapidly and automatically evaluates stimuli, and pre-empts an appropriate approach or avoidance response, allows conscious attention to be elsewhere and provides a safety net to keep the individual protected.

Duckworth, Bargh, Garcia, and Chaiken (2002) examined the automatic evaluation of novel stimuli. They showed that automatic evaluation occurred for novel pictorial, and novel auditory, stimuli. They then looked at whether novel stimuli could elicit an approach/avoid predisposition. Thus, they replicated Chen and Bargh's (1999) lever experiment, and did so using novel stimuli. The novel stimuli were pictures similar to abstract art, and had been rated as positive or negative by 72 participants who evaluated them in a forced choice computer task, and by an additional 42 participants who evaluated them in a Likert rating scale pencil and paper task.

The novel stimuli were presented one by one on the screen. Participants in the approach condition were instructed to pull the lever towards them as quickly as possible upon presentation of the stimuli. Participants in the avoid condition were instructed to push the lever away from them as quickly as possible upon presentation of the stimuli. Again, a random delay occurred between the beginning of the trial and

presentation of the stimuli so that participants could not anticipate stimulus appearance.

Results mirrored those of Chen and Bargh (1999); participants in the approach condition had quicker responses to positive than to negative stimuli, and vice versa for the participants in the avoid condition. Thus, congruent responses were faster than incongruent responses. Again, this difference was small; mean response time for congruent trials was 396ms, and for incongruent trials was 405ms (9ms difference).

Thus Duckworth et al (2002) demonstrated that automatic evaluation occurs for novel stimuli from different modalities, and that the link between automatic evaluation and approach-avoid behaviour extends from familiar stimuli to novel stimuli. This supports Chen and Bargh's (1999) conclusions about the adaptive nature of an evaluation-behaviour link.

Further support for this conclusion was provided by a paradigm introduced by De Houwer, Crombez, Baeyens, and Hermans (2001) in a paper that examined the generality of the affective Simon effect. In the paradigm, nouns and adjectives were presented one by one on a computer screen. Just before the word was presented a manikin appeared either above or below where the word would be positioned. The task was to decide the grammatical category (noun or adjective) of the word. Half the participants were instructed to make the manikin run towards nouns and away from adjectives (by pressing one of two keys; key 8 to move the manikin upwards, and key 2 to make the manikin move downwards), and the remaining participants were told to make the manikin run away from nouns and towards adjectives. The valence of the word was not mentioned.

De Houwer, Crombez, et al (2001) predicted that participants would be quicker to make the manikin move towards the positive words and away from

negative words, than to make the manikin move towards the negative words and away from positive words. Results confirmed this prediction. Reaction times were significantly quicker on congruent trials than on incongruent trials. This time the difference between the conditions was larger than for previous research in which no instruction to evaluate was given; congruent trials were 33ms quicker than incongruent trials.

This result supports the idea that automatic evaluations lead to a corresponding approach or avoid behaviour. De Houwer, Crombez, et al (2001) state that because the valence of the stimulus predisposed the direction of movement of an external representation of an individual (the manikin), then it is likely that valence can predispose the movement of the individual himself. They suggest that one mechanism for this predisposition to approach or avoid is that the valence of the stimulus biases the decision about which behaviour to execute.

Of course one criticism of De Houwer, Crombez, et al's (2001) research is that it might not truly measure automatic evaluation. Whilst the participants were indeed not instructed to evaluate the words they did have to make a decision based on the grammatical category. In order to make this decision participants would have to assess the meaning of the word, and so may have evaluated it for valence at the same time. Thus whilst the valence of the word is task irrelevant, the word itself, and its meaning, is task relevant.

A more recent study by Castelli, Zogmeister, Smith, and Arcuri (2004) also managed to produce congruency effects following automatic evaluation. Participants were shown pictures of white males. The pictures were accompanied with a label of child counselor or child molester. Then the participants completed a memory task. In this memory task participants were shown the previously seen male faces and a new

set of white male faces. The task was to indicate whether the pictures were old or new. In one block the participants moved their hand from a central button to a button nearer the screen (approach) for old items, and to a button further away from the screen (avoid) for the new items. In the other block these movements were reversed. Reaction times were recorded and data from the old items were analysed.

Results showed that participants were faster to approach the counselors than the molesters, but that there was no statistical difference between reaction times to avoid the counselors and the molesters. Looking at movements within each category showed that participants were faster to approach than to avoid the counselors (1180ms versus 1227ms), and, descriptively, but not statistically, faster to avoid than to approach the molesters (1238ms versus 1256ms). So although participants did not have to explicitly judge the category of the pictures their valence affected subsequent responses. These results show that it is the responses to approach the positive items that drive the effects and that this is where the hypothesis is supported. Congruency effects were not found for the other conditions thus suggesting that the effects might be hard to produce. In addition it is worth mentioning that although there was no explicit evaluation task within the memory task, participants had only just been explicitly given the face's category; so the study shows that items that have very recently been categorized can then have their valence automatically retrieved from memory and this can effect subsequent reactions. It does not show that any new item can be automatically judged and that this judgment affects responses.

The experiments in this chapter attempt to produce a congruency effect on an automatic evaluation task. This is important because approach/avoid responses might be different following automatic evaluation than following explicit evaluation. It would also allow us to test patients for deficits in the automatic evaluation and

approach/avoid response, which may be separate from deficits following explicit evaluation. In addition it is an interesting line of research as effects found in the automatic domain have been small and only a few studies have demonstrated them (Chen and Bargh 1999; Duckworth et al 2002; De Houwer, Crombez, et al 2001; Castelli et al, 2004). The conclusions from these studies have been the basis of paradigms used to examine whether approach and avoid tendencies produced by flexing and extending affect subsequent evaluation (Cacioppo, Priester, and Bernston, 1993; Cretenet and Dru, 2004). So it is important to investigate whether these automatic evaluation congruency effects can be produced.

Experiment 1

In Experiment 1 a modified version of the explicit evaluation task from the previous chapter was used. Specifically, the valenced stimuli were now task irrelevant and participants now touched the stimuli based on an arrow on the screen rather than an evaluation.

Method

Participants. Twelve undergraduates (eight female) participated for course credit. All were right handed, native English speakers, had normal vision, normal hearing, and no neurological problems. All gave informed consent and were debriefed after the experiment.

Stimuli. Picture stimuli were identical to those used in the explicit evaluation experiment. Word stimuli were not used in this experiment.

Design. The task employed in this experiment led to a mixed design with within-subjects factors of Side (Left/Right), Valence (Pleasant/Unpleasant), Arousal

(High/Low), and Task (Congruent = approach pleasant/avoid unpleasant. Incongruent = approach unpleasant/avoid pleasant). The dependent variable was Total Time to release key and touch the screen.

Procedure. The procedure was similar to that of the explicit evaluation experiment. The differences were that once the valenced picture and neutral stimulus appeared on the screen there was a delay of 300ms and then an arrow appeared in the centre of the screen pointing towards either the picture or the square. The participants' task was to touch the stimulus that the arrow pointed towards as quickly as possible. So if the arrow pointed towards the picture then the participants were expected to let go of the button reach out and touch the picture. This was classed as an approach movement. If the arrow pointed towards the square then the participants were expected to let go of then button reach out and touch the square. This was classed as an avoid movement. See Figure 4.1

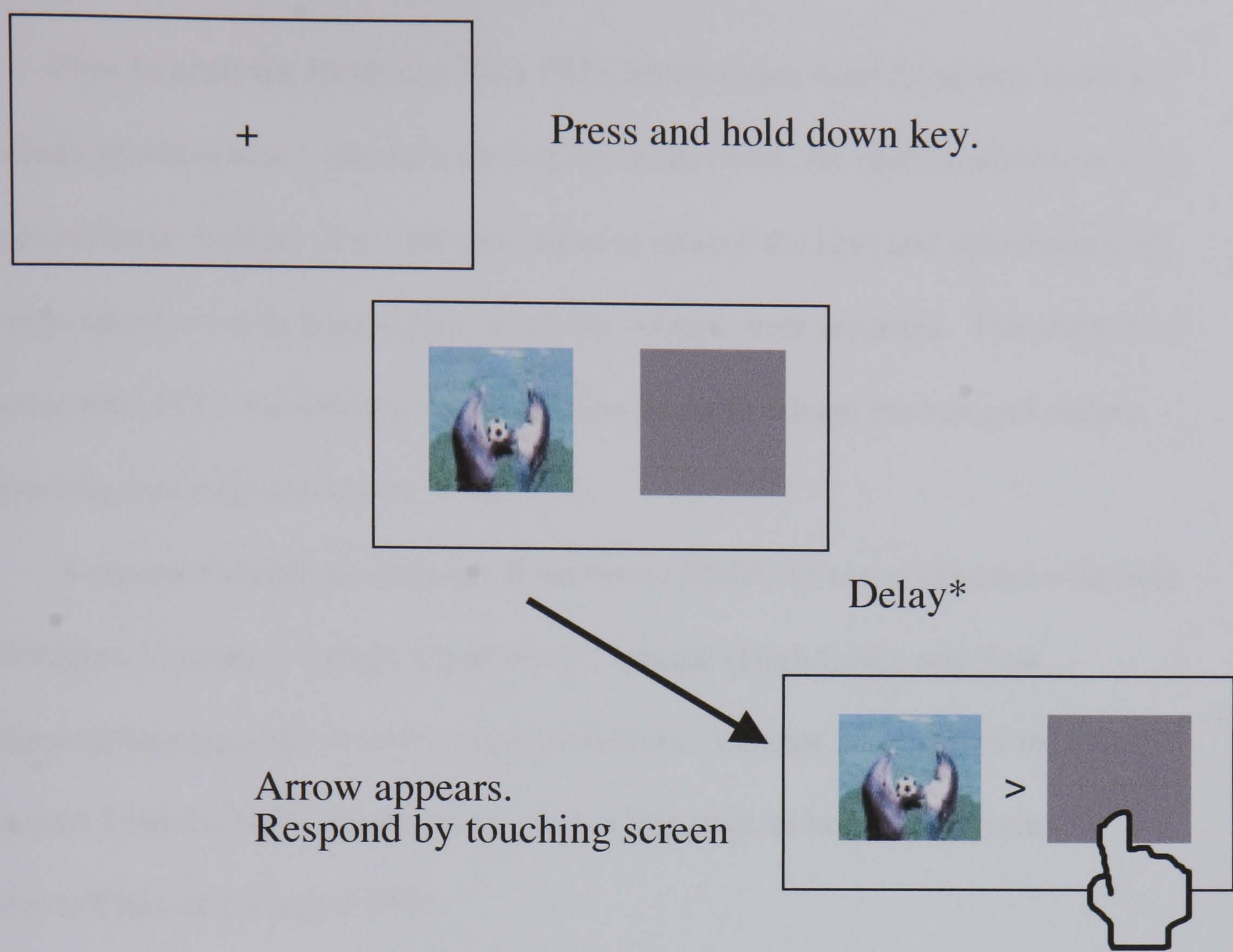

Figure 4.1. A diagram depicting the sequence of events in the automatic evaluation task. In Experiment 1 the delay* was 300ms. In Experiment 2 the delay* varied and could be 150ms, 500ms, or 1000ms.

Results and Discussion.

Prior to analysis, Response Time (RT) distributions were iteratively trimmed to include scores within 3 standard deviations of the mean, for each condition and for each participant. Release time (the time taken to release the key) and movement time (the time taken to reach towards and touch the screen) were recorded. The analysis of response time (RT) was based on the total time taken to release the key and make a response by touching the screen.

A repeated measures analysis of variance (ANOVA) was conducted with Side (Left/Right), Valence (Pleasant/Unpleasant), Arousal (High/Low), and Task (Congruent/Incongruent) as within subjects factors. Valence was determined using the norms from the IAPS. Norms were used at this stage to keep the experiment similar to Chen and Bargh (1999).

The analysis showed that the main effect of Task was not significant. The Congruent condition yielded similar reaction times to the Incongruent condition (Congruent M = 669ms, SD = 146.4, Incongruent M = 671.5ms, SD = 209.8), $F(1,11) = .380$, $p = .550$. So participants were not faster to approach the pleasant stimuli and to avoid the unpleasant stimuli than they were to approach the unpleasant stimuli and avoid the pleasant stimuli.

There were a few other significant effects that were not critical to our hypothesis: The main effect of Side was almost significant, $F(1,11) = 3.88$, $p = .075$, showing that participants were slightly faster to respond to items on the Right than the Left. This effect is modified a significant interaction of Side by Valence by Task, $F(1,11) = 18.22$, $p = .001$. Basically this means that participants were faster to approach items on the right and avoid items on the left. This is probably an artefact

of the experimental task; right-handed participants are faster to touch items on the right, and to avoid items on the left by touching the neutral item on the right.

There were no other significant effects.

Because a congruency effect was not found, the reaction time and movement time data were analysed separately for these automatic evaluation experiments to check whether a congruency effect might be occurring at just the reaction time, or the movement time, stage and might be masked by an analysis of total time. Solarz (1960) only found an effect at the reaction time stage whereas Chen and Bargh (1999) found an effect after moving the lever a certain amount of degrees, which corresponds more closely to our total time. Thus it is important to examine my results more closely.

The analysis on the reaction time and movement time revealed that there were no congruency effects at either the reaction time, $F(1,11) = 0.000$, $p = .989$, or the movement time stage, $F(1,11) = 0.305$, $p = .592$. (Tables presenting reaction time, movement time, and total time, means and statistics for all experiments can be found in the appendix).

Experiment 2.

Experiment 1 failed to produce a congruency effect. In Experiment 1 participants were presented with the stimuli and then had to wait for 300ms until the arrow appeared to direct their responses. Perhaps this delay was responsible for the lack of a congruency effect in the experiment. Chen and Bargh (1999) had no delay between stimulus presentation and response, so this might be the crucial difference between the experiments in producing a congruency effect. In Experiment 2 the stimulus onset asynchrony was varied to determine whether the effect might occur immediately and then be overridden after a certain amount of time. A congruency effect might be expected on the trials in which participants can respond immediately, but not when participants are prevented from responding immediately.

Method

Participants. Twelve undergraduates (ten female) participated for course credit. All were right handed, native English speakers, had normal vision, normal hearing, and no neurological problems. All gave informed consent and were debriefed after the experiment.

Stimuli. Stimuli were identical to those in the previous experiment.

Design. The design was identical to the one in the previous experiment with the added within subjects factor of Delay (Short = 150ms, Medium = 500ms, Long = 1000ms).

Procedure. The procedure was the same as in the previous experiment with one exception. There was now a variable delay of 150ms, 500ms, or 1000ms between the onset of the visual stimuli and the arrow pointing towards either the picture or the square. Refer back to Figure 4.1. The delays occurred in a random order to ensure that

the participants could not predict what would happen on each trial. Each of the three delays occurred an equal amount of times.

Results and Discussion

RTs were calculated as in Experiment 1. A repeated measures analysis of variance (ANOVA) was conducted with Side (Left/Right), Valence (Pleasant/Unpleasant), Arousal (High/Low), Task (Congruent/Incongruent) and Delay (Short, Medium, Long) as within subjects factors.

The analysis showed that the main effect of Task was not significant, $F(1,11) = 1.75$, $p = .213$. The Congruent condition yielded similar reaction times to the Incongruent condition (Congruent M = 840.4ms, SD = 234.6, Incongruent M = 830.8ms, SD = 246.1). So overall participants were not faster to approach the pleasant stimuli and to avoid the unpleasant stimuli than they were to approach the unpleasant stimuli and avoid the pleasant stimuli.

The interaction of Task by Delay was not significant, $F(2,22) = 0.041$, $p = .96$. There was no congruency effect for any of the delays. See Figure 4.2.

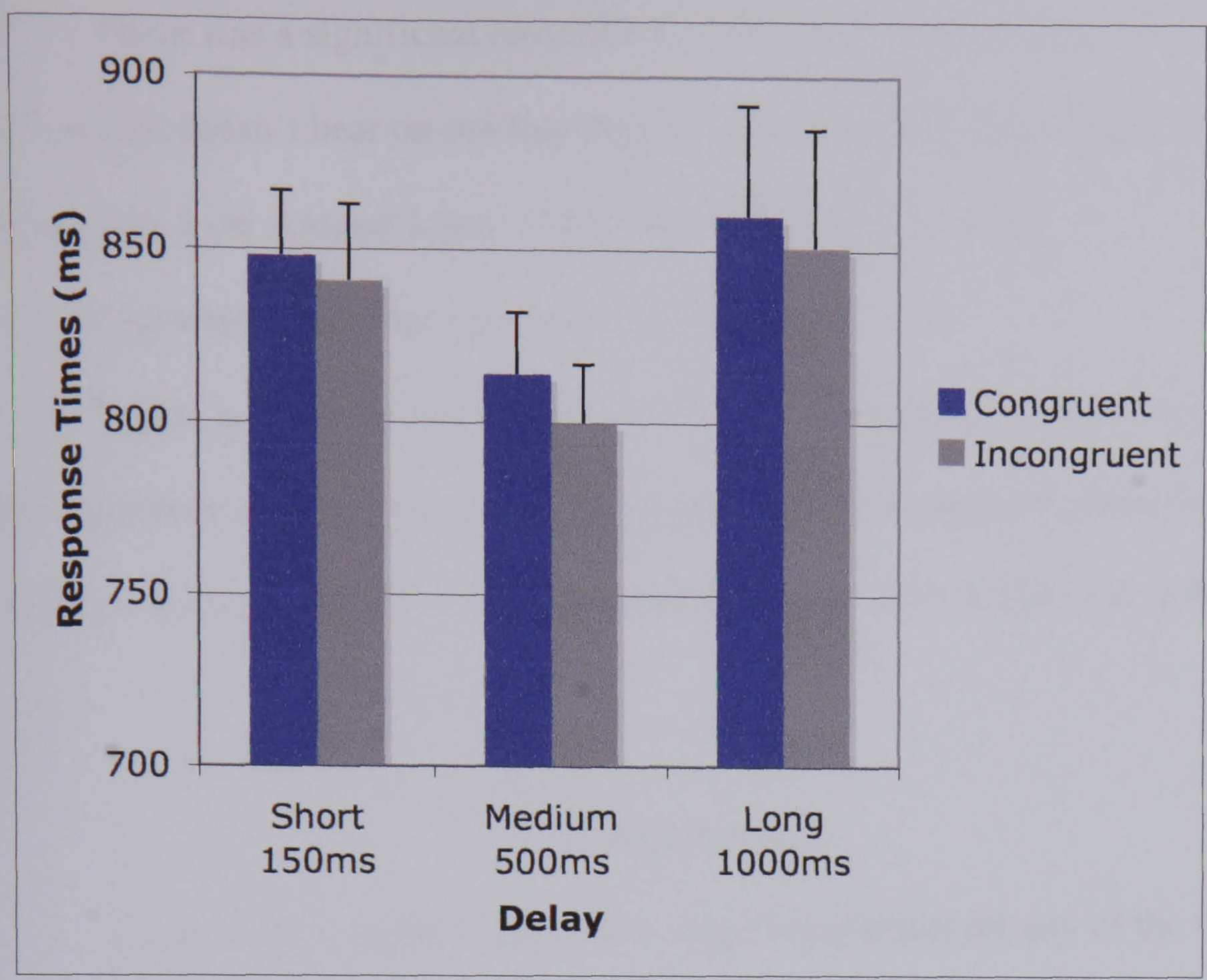

Figure 4.2 A graph showing Response Times for the Congruent and Incongruent conditions at each of the three Delays.

There were a few other significant effects that were not critical to our hypothesis: The main effect of Side was significant, $F(1,11) = 8.004$, $p = .016$, showing that participants were faster to respond to items on the Right than the Left (Left M = 861.9, SD= 285.6, Right M = 809.2, SD = 108.2).

There was a significant interaction of Side by Valence by Task, $F(1,11) = 12.67$, $p = .004$. Again this means that participants were faster to approach items on the right and avoid items on the left. And is probably an artefact of the experimental task; right-handed participants are faster to touch items on the right, and to avoid items on the left by touching the neutral item on the right.

There was a significant interaction of Arousal by Delay $F(1,11) = 7.89$, $p = .017$, which doesn't bear on our hypotheses. (High Arousal Long = 828, Med = 809 Short =856, Low Arousal Long = 884, Med = 805, Short = 833)

There were no other significant effects.

Again an analysis was carried out on the reaction time and movement time data separately and this revealed no congruency effect at either the reaction time, $F(1,11) = 0.122$, $p = .733$, or the movement time, $F(1,11) = 1.207$, $p = .295$, stage.

Experiment 3.

Experiment 2 failed to produce a congruency effect for any of the three delays. Participants were faster to avoid the stimuli than approach them regardless of valence. This could have been due to inhibition of return (IOR). In this explanation attention would revert away from the valenced stimuli to the arrow and then it would be harder to attend to the valenced stimuli immediately, thus making approach responses artificially slow. This produces a problem for the pleasant items in which IOR is working against the congruency effect. Thus there may be a problem using pleasant stimuli in this particular task. So in Experiment 3 the pleasant items were removed and replaced with neutral items. If participants were still faster to avoid than to approach for the unpleasant items, and had similar approach and avoid response times for the neutral items, then a congruency effect for unpleasant items on an automatic task will have been produced. This paradigm might then be suitable for patients with deficits recognizing fear, threat, and negative emotions.

Method

Participants. Twelve undergraduates (nine female) participated for course credit. All were right handed, native English speakers, had normal vision, normal hearing, and no neurological problems. All gave informed consent and were debriefed after the experiment.

Stimuli. In this experiment only the 40 unpleasant pictures from the previous experiment were used. These fall into two categories: high and low arousal. The arousal ratings for these categories are 6.2 and 4.1 respectively. These were compared to a set of 40 neutral pictures, taken from the International Affective Picture System, Lang (1999), with an average valence rating of 5.1 and arousal rating of 3.1.

Design. The design was the same as in the previous experiment but with the added within subjects factor of Valence (Unpleasant High Arousal/Unpleasant Low Arousal/Neutral) and the deletion of the within subjects factors of Arousal and Task. So in this experiment there were within subjects factors of Side, Behaviour, Valence, and Delay.

Procedure. The procedure was identical to that of the previous experiment.

Results and Discussion

RTs were calculated as in Experiment 1. A repeated measures analysis of variance (ANOVA) was conducted with Side (Left/Right), Behaviour (Approach/Avoid), Valence (HighUnpleasant/LowUnpleasant/Neutral), and Delay (Short, Medium, Long) as within subjects factors. This differs from the previous analyses based on Congruent versus Incongruent conditions because the introduction of the neutral stimuli prevents this comparison.

In this analysis the congruency effect would be seen by an interaction of Behaviour by Valence. The analysis showed that this interaction was not significant.

F(2,22) = 0.007, p = .993. So participants were not faster to avoid than to approach the unpleasant stimuli. In fact participants were faster to approach than to avoid both unpleasant and neutral stimuli, (Approach M = 762.4, SD= 105.76, Avoid M = 776.01, SD = 99.27) demonstrated by the significant main effect of Behaviour, F(1,11) = 15.29, p = .002, Figure 4.3. This is in contrast to the results of Experiment 2, which showed faster avoid responses to all stimuli. It is not clear why a different pattern of results occurred in Experiment 2 and Experiment 3, but it does not seem that IOR is exerting an effect in this experiment.

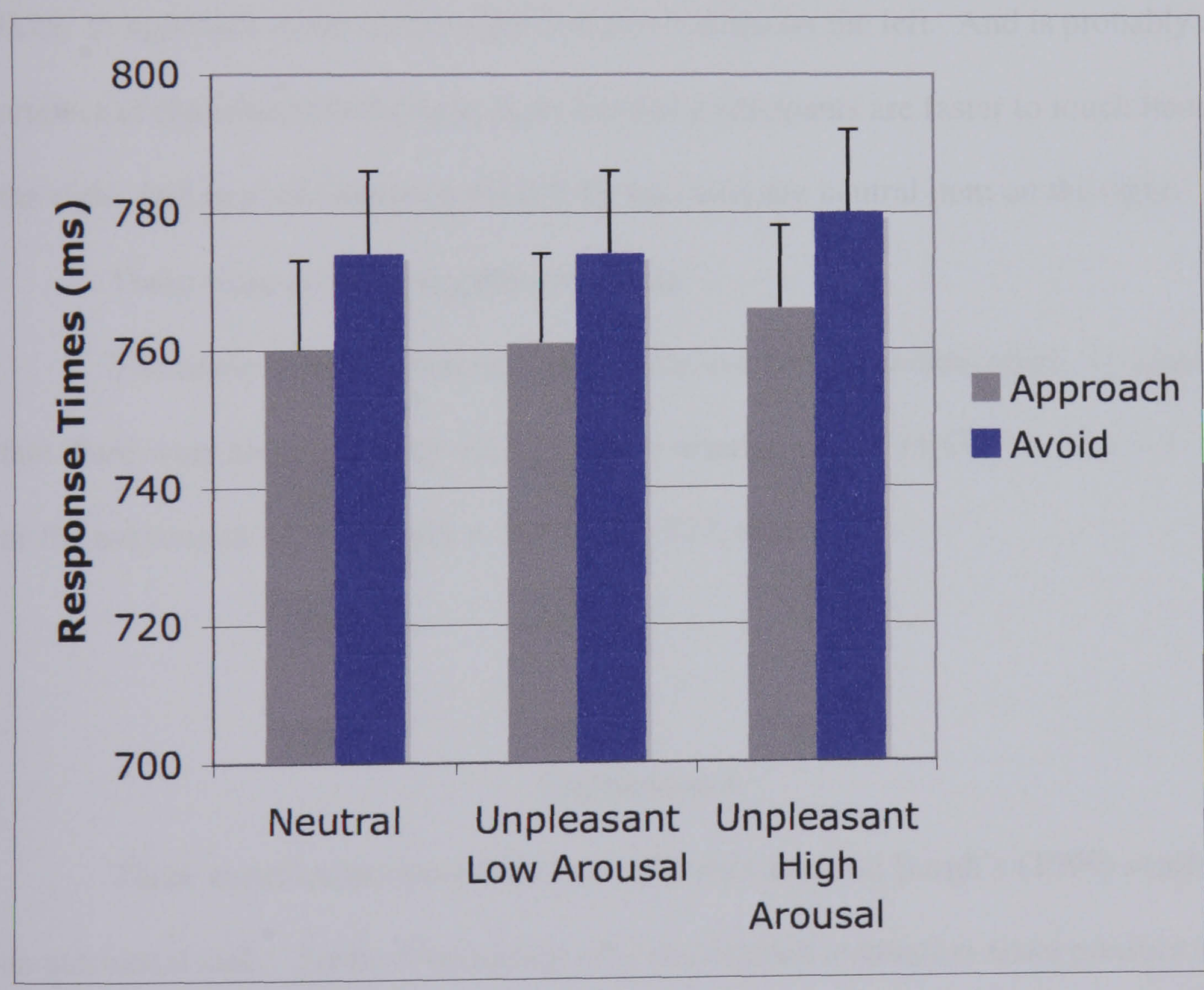

Figure 4.3. A graph showing that participants were faster to approach than to avoid all stimuli.

The interaction of Behaviour by Valence by Delay was not significant, $F(4,44) = 0.26$, $p = .902$. There was no congruency effect for any of the Delays.

There were a few other significant effects that were not critical to our hypothesis: The main effect of Delay was significant, $F(2,22) = 30.10$, $p < .001$, showing that participants were faster to respond to Long trials, and slowest to respond to Short trials. (Long M = 737, SD= 85.8, Medium M = 752.5, SD = 91.04, Short M = 818.1, SD= 111.4).

Finally there was a significant interaction of Side by Behaviour, $F(1,11) = 19.62$, $p = .001$. As in the previous experiments this shows that participants were faster to approach items on the right and avoid items on the left. And is probably an artefact of the experimental task; right-handed participants are faster to touch items on the right, and to avoid items on the left by touching the neutral item on the right.

There were no other significant effects.

The analysis on the reaction time and movement time data, again, revealed that there were no congruency effects for the reaction time, $F(1,11) = 1.785$, $p = .191$ or the movement time, $F(1,11) = 0.282$, $p = .757$, data.

Experiment 4

Three experiments have failed to replicate Chen and Bargh's (1999) results on an automatic task. So far it is unclear why the explicit evaluation tasks produce such large congruency effects whilst the automatic tasks do not. The major difference in the tasks is obviously the evaluation of the stimuli. Clearly, evaluating the stimuli on each trial, as in the explicit evaluation paradigm, produces a congruency effect. Experiments 4 and 5 examine whether evaluating stimuli before an automatic task,

can produce a congruency effect on the task (as in Castelli, 2004). Perhaps participants would then be in an evaluating frame of mind, or would be sensitive to the valence of the stimuli because they had recently evaluated them.

Experiment 4 was designed so that it could examine whether any congruency effect that might be found occurred because each stimuli had been rated or because the participant had done a rating task with some stimuli and had therefore had their attention drawn to valence in general. A within subjects design, where participants rated half the stimuli before the task and half after, was used. Stimuli which had been rated before were placed in the Before category and stimuli which had been rated after were placed in the After category. So the After category would have the general rating effect – participants had rated stimuli, but not those that appear in the task. The Before category would have the specific rating effect – the items in the experiment had been rated before. In addition the rating task allows us to use idiosyncratic categorization of valence for the stimuli in the task, rather than norms from the IAPs. Chen and Bargh (1999) produced an automatic evaluation congruency effect using normative data, but given the debate between Bargh et al (1992) and Fazio (1993) discussed in the literature review in Chapter 2, in which Fazio argued the importance of idiosyncratic ratings, it is possible that using idiosyncratic ratings might reveal effects that could be masked by using normative ratings.

Method

Participants. 8 undergraduates (all female) participated for course credit. All were right handed, native English speakers, had normal vision, normal hearing, and no neurological problems. All gave informed consent and were debriefed after the experiment.

Stimuli. Picture stimuli were the same as in the previous experiments although this time they were just categorized by valence, and not also by arousal. Word stimuli were the same as in the explicit evaluation experiments. The neutral stimulus was a grey square. This was 8x8cm.

Design. The task employed in this experiment led to a mixed design with within subjects factors of Side (Left/Right), Behaviour (Approach/Avoid), Valence (Pleasant/Unpleasant) and Stimulus Type (Picture/Word) and the critical within subjects factor of Rating (rating Before or After). The interaction of Behaviour by Valence gives us the factor of Task used in previous experiments. The dependent variable was Total Time to release the key and make a response on the screen.

Procedure. The Picture and Word tasks were essentially the same. A fixation-cross appeared in the centre of the screen. The participant started the trial by pressing the large button on the keypad with their right hand and keeping the button depressed. A random delay of 500ms or 1500ms occurred (to prevent anticipation) and then the valenced stimulus (picture/word) appeared on one side of the screen, the neutral stimulus (the grey square) on the other, and an arrow in the centre. The participants could now let go of the button and respond. Once again the task was to touch whatever the arrow pointed towards. Once they had made a response the stimuli disappeared and the fixation cross for the next trial appeared. See Figure 4.4.

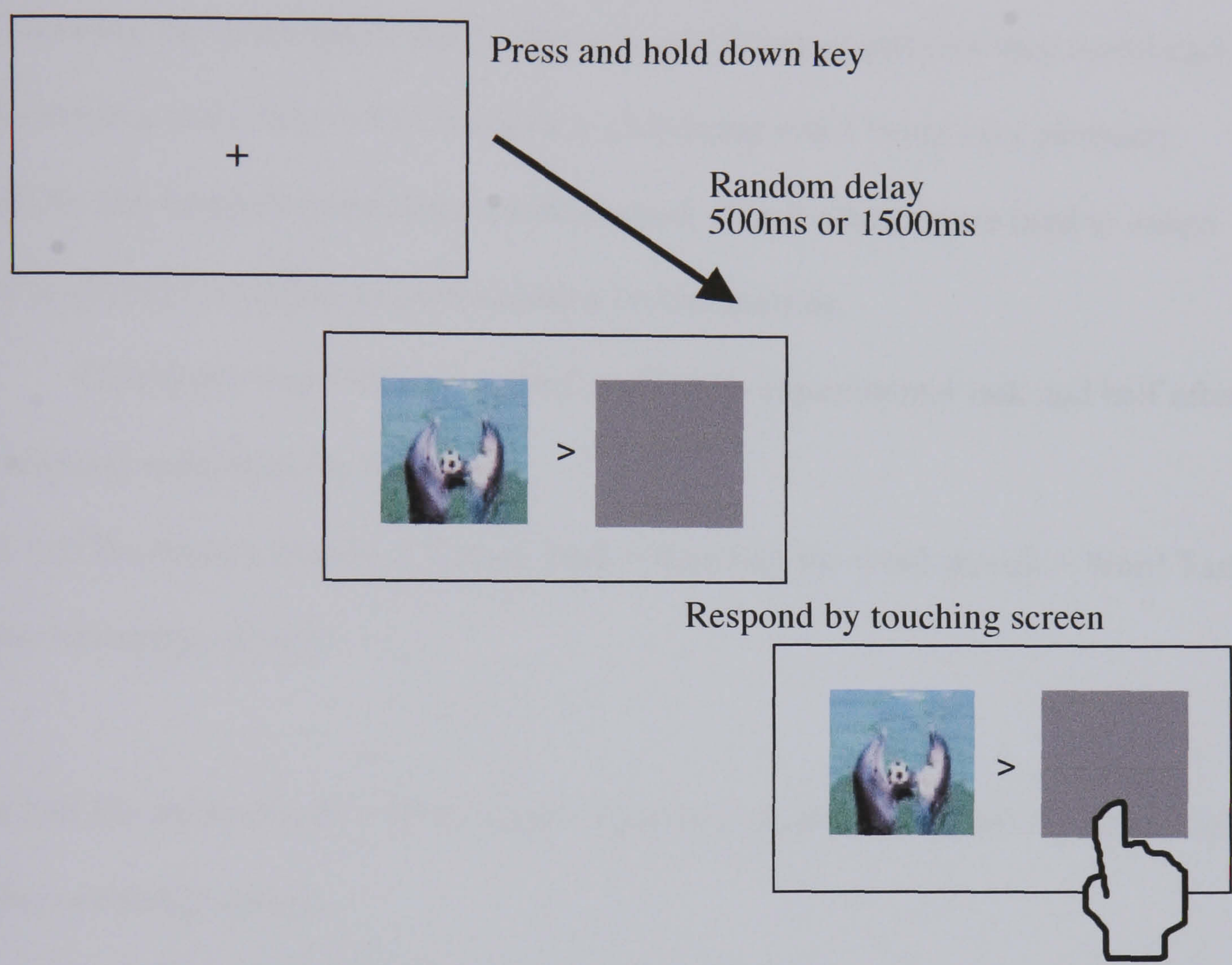

Figure 4.4. A diagram depicting the sequence of events in the main experimental task of Experiments 4 and 5. The word task was identical to the picture task.

Each task (picture or word) was split into two blocks of equal number of trials. In the picture task each picture was presented twice – once on each side. This led to 160 trials in each block and 320 trials altogether. In the word task each word was also presented twice – once on each side. This led to 184 trials in each block and 368

trials altogether. Within the blocks the Pictures or Words were presented in a random order. Each block took between 5 and 10 minutes. The tasks were counterbalanced so that half of the participants did the Picture task first and half did the Word task first.

In addition to the main experimental tasks participants completed the critical rating task. In this task the picture and word stimuli appeared one by one in the centre of the screen and participants had to rate how unpleasant or pleasant they found each stimulus on a scale from 1-7 (1 being very unpleasant and 7 being very pleasant). They did this using allocated keys on the keypad. These ratings were used to assign each participant's valence to each stimulus for the analysis.

Participants rated half the stimuli before the experimental task and half after. Participants completed the following:

Rate half the picture stimuli > Picture Task > Rate half the word stimuli > Word Task > Rate remaining stimuli.

Or

Rate half the word stimuli > Word Task > Rate half the picture stimuli > Picture Task > Rate remaining stimuli.

Stimuli which had been rated before the task were placed in the Before category, and stimuli that had been rated after the task were placed in the After category. This meant that stimuli in the Before condition shown in the experimental task would have been specifically rated for valence, thus allowing us to see whether rating the particular stimulus produces a congruency effect. Stimuli in the After condition shown in the experimental task had not been specifically rated - but attention to the valence of items had been generally made by rating other stimuli beforehand – this allowed us to see whether drawing attention to valence in a general way produced a congruency effect.

Results and Discussion.

A repeated measures analysis of variance (ANOVA) was conducted with Side (Left/Right), Behaviour (Approach/Avoid), Valence (Pleasant or Unpleasant) and Stimulus Type (Picture/Word) as within subjects factors, and the critical factor or Rating (Before/After) also as a within subjects factor. The interaction of Behaviour by Valence gives us the Task factor used in previous experiments.

Results showed that the interaction of Behaviour by Valence by Rating was not significant $F(1,7) = 2.14$, $p = .187$. There was no congruency effect in either condition.

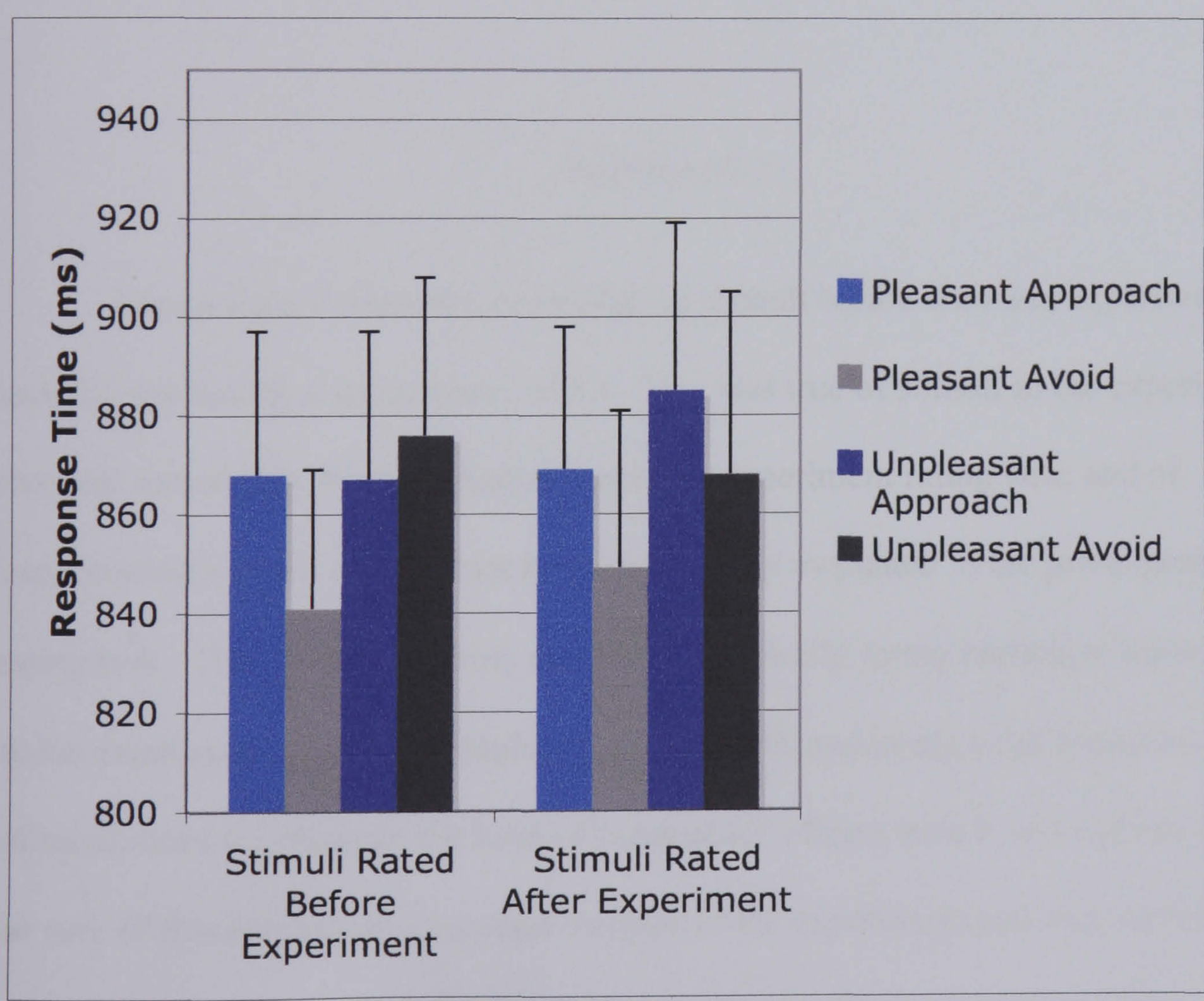

Figure 4.5. A graph showing Response Times for stimuli that have been evaluated Before the experiment and After the experiment.

The interaction of Behaviour by Valence was not significant $F(1, 7) = 1.49$, $p = .262$. Once again participants were not faster to approach the pleasant stimuli and to avoid the unpleasant stimuli than they were to approach the unpleasant stimuli and avoid the pleasant stimuli. (Approach pleasant M = 868.4, SD = 162, Approach Unpleasant M = 875.9, SD = 180.5, Avoid Pleasant M = 845.2, SD = 170.2, Avoid Unpleasant M = 872.1, SD = 192.7).

There were no other significant effects.

Experiment 5

Experiment 4 showed that evaluating stimuli before the main experimental task did not lead to a congruency effect. This was true of stimuli in the experiment that had specifically been evaluated in the pre-experiment rating task, and of experimental stimuli that had not been specifically evaluated in the pre-experiment rating task. This seemed to show that both specifically rating particular stimuli seen in the experiment, and that completing a rating task and being in an evaluative frame of mind, does not produce the kind of congruency effects seen in my explicit task. To be sure of this conclusion a stronger version of the experiment was run, with more participants, using a between subjects design where participants either rated all the stimuli before the task, or all after. If no congruency effect occurs in this experiment then it can safely be concluded that evaluating stimuli before the task does not create

a congruency effect in an automatic task, and that with regard to evaluation, online concurrent evaluation on each trial is needed to produce the kind of effects seen in the explicit evaluation task.

Method

Participants. Thirty six undergraduates (thirty three female) participated for course credit. All were right handed, native English speakers, had normal vision, normal hearing, and no neurological problems. All gave informed consent and were debriefed after the experiment.

Stimuli. Stimuli were identical to those used in the previous experiment.

Design. The design was identical to the one used in the previous experiment with the exception that the *within* subjects factor of Rating (Before/After) was replaced with the *between* subjects factor of Rating (Before/After)

Procedure. The procedure was the same as in the previous experiment with one exception; participants were now in one of two conditions. Participants in the Before condition rated each stimulus in the experiment before completing each task. So they rated all the pictures before the picture task and then all the words before the word task. For example participants in the Before condition completed the following:

Rate all the picture stimuli > Picture Task > Rate all the word stimuli > Word Task. Or Rate all the word stimuli > Word Task > Rate all the picture stimuli > Picture Task.

Participants in the After condition rated all the pictures and then all the words (or vice versa) after the experimental task. Participants in the After condition completed the following: Picture Task > Word Task > Rate all Pictures > Rate all Words. Or Word Task > Picture Task > Rate all Words > Rate all Pictures. These

ratings were used to assign the actual participant's valence to each stimulus for the analysis. Picture and Word tasks were counterbalanced so that half the participants completed Picture rating and Picture task first and half completed Word rating and Word task first.

Results and Discussion.

RTs were calculated as in Experiment 1. A repeated measures analysis of variance (ANOVA) was conducted with Side (Left/Right), Behaviour (Approach/Avoid), Valence (Pleasant/Unpleasant), Stimulus Type (Picture/Word) as within subjects factors, and the critical factor of Rating (Before/After) as a between subjects factor. In this analysis the congruency effect would be seen by an interaction of Behaviour by Valence.

The critical interaction of Behaviour by Valence by Rating was not significant, $F(1,34) = 0.589$, $p = .448$. There was no congruency effect for the Before or After groups. See Figure 4.6. Thus rating the stimuli before the main experimental task did not lead to a congruency effect.

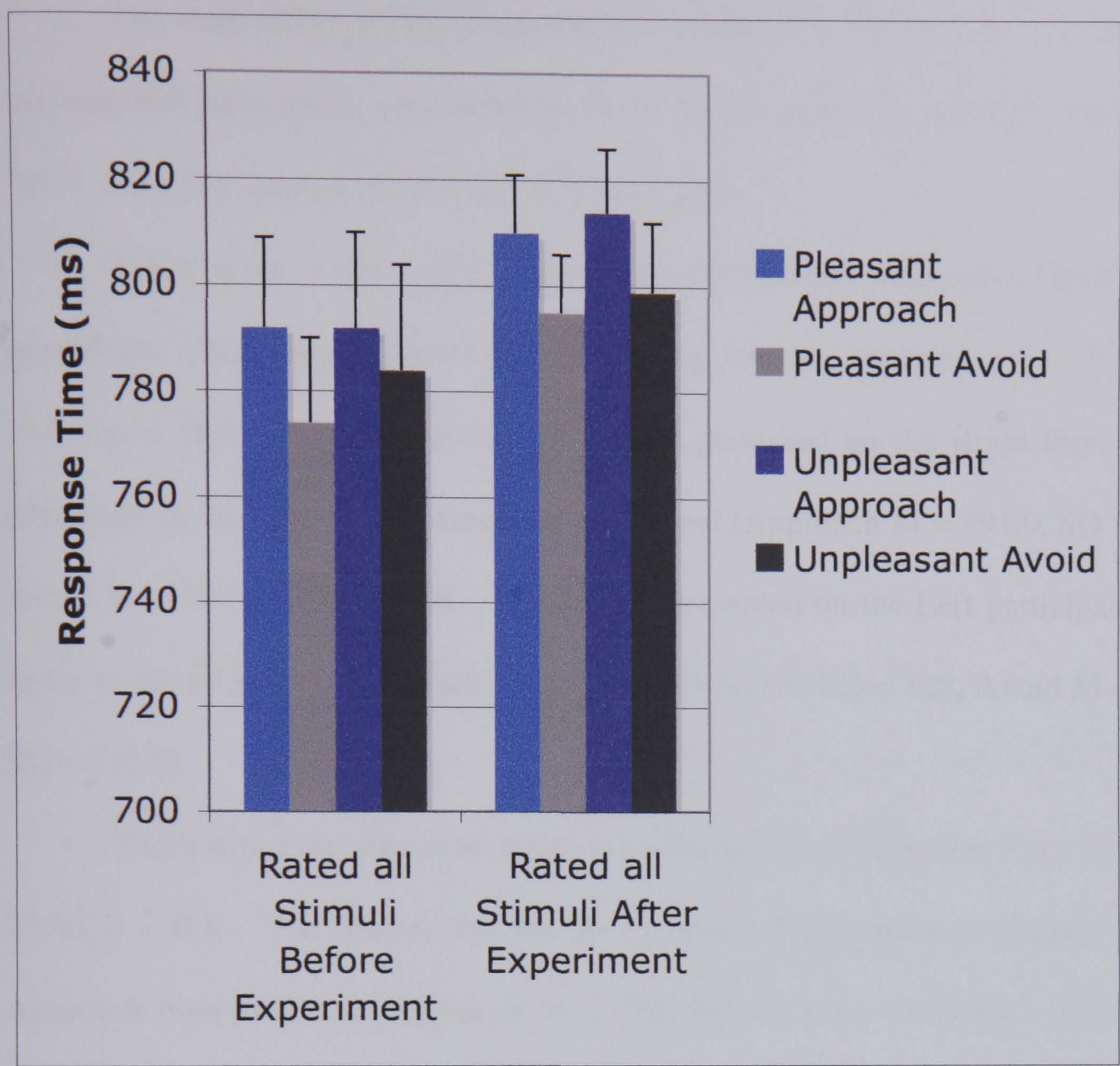

Figure 4.6. A graph showing Response Times in the Congruent and Incongruent conditions for participants who rated all stimuli Before, and for participants who rated all stimuli After, the main experimental task.

The analysis showed that the interaction of Behaviour by Valence was not significant. $F(1,34) = 0.628$, $p = .433$. Overall participants were not faster to approach the pleasant stimuli and to avoid the unpleasant stimuli, than to approach the unpleasant stimuli and avoid the pleasant stimuli. (Approach Pleasant M = 800.7, SD = 123.3, Approach Unpleasant M = 803, SD = 131.9, Avoid Pleasant M = 784.2, SD = 120.3, Avoid Unpleasant M = 791.3, SD = 141.2).

The main effect of Behaviour was significant, $F(1, 34) = 13.98$, $p = .001$, showing that participants were faster to Avoid than to Approach overall (Avoid M = 787.7, SD= 131, Approach M = 801.9, SD = 127.4).

There were a few other significant effects that were not critical to our hypothesis. There was a significant interaction of Side by Behaviour, $F(1, 34) = 18.03$, $p < .001$. This showed that for stimuli presented on the Right there was no difference in the time participants took to respond (Approach M = 791.9, SD = 126.4, Avoid M = 791.7, SD = 126.8). For stimuli presented on the Left participants were faster to Avoid than to Approach (Approach M = 811.9, SD = 128, Avoid M = 783.8, SD = 135.5).

There was a significant interaction of Behaviour by Stimulus Type $F(1, 34) = 21.96$, $p < .001$. This showed that for the Pictures participants were slightly faster to Approach than to Avoid (Approach M = 792, SD = 139.1, Avoid M = 799.6, SD = 140.9). For the Words participants were faster to Avoid than to Approach (Approach M = 811.8, SD = 114.2, Avoid M = 775.9, SD = 119.8).

There was also a significant interaction of Side by Behaviour by Stimulus Type, $F(1,34) = 6.69$, $p = .014$. This showed that participants were faster to Avoid than to Approach for Pictures and Words on the Left and for Words on the Right. For Pictures on the Right participants were faster to Approach than to Avoid.

The main effect of Side neared significance $F(1, 34) = 4.08$, $p = .051$, which showed that participants were faster to respond to stimuli on the Right than on the Left (Right M = 791.8, SD = 126.4, Left M = 797.9, SD = 132.4)

There were no other significant effects

Discussion.

So far all variations of the automatic task have failed to produce any real congruency effect and certainly nothing that mirrors the size of the one obtained in the explicit task. Approaching or avoiding the stimuli based on the direction of an arrow, rather than on the explicit evaluation of the stimuli, did not produce a congruency effect. An effect was still not obtained when the stimulus onset asynchrony was varied so that participants could respond very quickly to the stimuli and that this could be compared to trials on which participants had to wait before they could respond. In these experiments participants were faster to avoid overall than to approach, regardless of valence. In a third experiment the pleasant stimuli were removed and neutral stimuli added. If participants were faster to avoid than to approach for the unpleasant stimuli, and yet had similar reaction times to approach and avoid the neutral stimuli, then this might be a task suitable for measuring patient responses to unpleasant stimuli. Once again though no congruency effect was obtained. Ironically in this experiment participants were now slightly faster to approach stimuli than avoid, regardless of valence.

The major difference between the explicit evaluation tasks, which produce very large congruency effects, and the automatic tasks, which so far produce no congruency effect, is the act of categorising the stimuli as pleasant or unpleasant. In the fourth and fifth experiments the effect of rating the stimuli before the automatic task was examined, to see if this would produce an effect. The prediction was that having the participants rate the stimuli as pleasant or unpleasant, before completing the automatic experiment, would produce congruency effects in the automatic experiment. If this were the case it would question the automaticity of the

approach/avoid mechanism, and suggest that explicit evaluation needs to be present for the effect to occur. The results show that the effect of rating before the experimental task did not produce a large congruency effect as seen in the explicit evaluation task.

Rating some or all of the stimuli before the experimental task did not affect the way participants respond to the task; there was no congruency effect for these conditions. Thus it is clear that simply the act of rating or categorising the stimuli does not produce the kinds of congruency effects seen in the explicit evaluation task. If the rating/categorising is the major thing driving the congruency effect in the explicit evaluation task then it seems that it needs to be completed for each stimuli before each trial (as in the explicit evaluation task).

The rating of the stimuli is one major difference but it seems that this alone does not produce an effect. The other difference between the automatic tasks and the explicit evaluation task is that in the explicit evaluation task participants are making a decision and the response is based on that decision for each trial. In the automatic task no decision is necessary as the participants simply respond by following the arrow. It could be that drawing attention to the valence, coupled with a task on each trial, and therefore a larger cognitive load, may be needed to produce these large congruency effects. This would tie in with Chen and Bargh's (1999) description of the reasons behind the effect: that the approach/avoid congruency effect is an automatic evolutionary detection system to direct resources towards threat/reward whilst attention is elsewhere. It could be that this system works whilst consciously having to evaluate the stimuli and base your response on that, and that it also works whilst not evaluating the stimuli but when cognitive load is high and attention is elsewhere. But that it does not work, or is overridden, when the task is easy and the

valence has not been made obvious. In this case it may be easy to override the mechanism, especially when the stimuli are pictures and not actual threats or rewards. This may explain the results I have been getting but it is a post hoc explanation. It also doesn't account for Chen and Bargh's results in their automatic task. Their automatic task was easy and placed no cognitive load upon the participants and they still found a congruency effect, although the effect was small and the number of participants large.

My experiments have a much smaller number of participants than Chen and Bargh (1999), and this reduces their power. If a larger number of participants were used perhaps a small congruency effect, like the effect found in Chen and Bargh, would have been found. But this would still mean that my automatic task would be unsuitable for patient based testing. Thus I did not explore this option further as the main aim was to produce a patient suitable task.

My experiments with the automatic task suggest that this approach/avoid mechanism is not as robust or widespread as implied. Clearly for it to occur after automatic evaluation certain constraints need to be present. So far I have not been able to identify or isolate these although the cognitive load aspect is a possibility.

Since completion of these experiments Rotteveel and Phaf (2004) produced a series of experiments that are consistent with my results and argued that automatic evaluation does not automatically predispose for arm flexion and extension, as Chen and Bargh (1999) claimed. Rotteveel and Phaf used a new paradigm involving 3 button boxes on a vertical stand. Participants started with their hands pressing the home button in the middle of the stand. They then responded by either pressing the lower button, which involved extending the arm, or pressing the upper button, which involved flexing the arm.

In the first experiment Rotteveel and Phaf (2004) used an explicit evaluation task. Participants had to evaluate facial expressions. In the congruent condition participants had to push the upper button for positive expressions, and the lower button for negative expressions. In the incongruent condition they were instructed to do the opposite. Results revealed participants were faster to flex to positive stimuli and extend to negative stimuli, than vice versa. Rotteveel and Phaf therefore demonstrated a congruency effect on an explicit task on their new paradigm.

The second experiment was an automatic evaluation task. Using the same paradigm as before, participants now based their responses on the gender of the face rather than the valence. This time no congruency effect was observed; participants were not faster to flex to positive and to extend to negative stimuli, than vice versa. So although participants reported noticing the expressions, there was no influence of affect on arm flexion and extension when there was no instruction to explicitly evaluate the stimuli. Thus their results so far are similar to mine.

Their third experiment used a sequential priming task to investigate whether automatically evaluated primes exerted an influence on flex and extend movements or whether only the explicitly evaluated targets would create a congruency effect. A prime face with a positive or negative expression preceded a target picture that the participants had to categorize as pleasant or unpleasant. As in the previous experiments, participants in the congruent condition were instructed to push the upper button for positive pictures, and the lower button for negative pictures. In the incongruent condition they were instructed to do the opposite. So in this task attention to the relevant dimension of valence was achieved for the primes even though participants were not instructed to explicitly evaluate them. Results showed that a congruency effect occurred for the target pictures but not for the prime faces.

Additionally, if prime and target matched in valence then responses were faster than if prime and target did not match. This experiment therefore showed that the primes were indeed automatically evaluated, but that this did not lead to predispositions to flex and extend. Only the targets that were explicitly evaluated produced a congruency effect. Rotteveel and Phaf (2004) concluded that the link between affect and arm flexion and extension depends on deliberative conscious processing of the stimuli. This is consistent with my results. I found a congruency effect on my explicit evaluation tasks but failed to produce one on several automatic versions.

The lack of a congruency effect on an automatic evaluation task has implications for creating a paradigm for patient based research. Because of the lack of, or very small, congruency effects on automatic evaluation tasks it seems unlikely that it is possible to produce an automatic evaluation paradigm suitable for patient testing. Patients are tested individually and need to be compared to other individuals' results in addition to group means. This means that a task suitable for the patients would have to produce large and reliable effects for each person in order to provide a sound basis for comparison. This has not been demonstrated on any automatic task. This is disappointing as an automatic evaluation task would suit patients with difficulties in explicitly evaluating stimuli; however the explicit version still provides an extremely useful tool in the investigation of the brain areas responsible for the approach and avoid response.

My results, and those of Rotteveel and Phaf (2004), have implications for research looking at how approaching and avoiding can affect subsequent evaluations. Cacioppo, Priester, and Bernston (1993) looked at how motor positions could affect subsequent attitudes. They based their experimental paradigm on research on classical conditioning (Zanna, Kiesler, and Pilkonis, 1970). This argues that over an

individual's lifetime arm flexion is paired more often with positive motivational orientations, for example approach, and extension paired more often with negative motivational orientations, for example avoid. Following this argument, Cacioppo et al use the idea that arm flexion would give bodily feedback associated with approaching positive stimuli, and arm extension would give bodily feedback associated with avoiding negative stimuli. Therefore, Cacioppo et al used flex and extension positions to induce motivational states. Approach tendencies were evoked by getting participants to assume a flexing position, by placing the palm on the underside of a table and exerting slight pressure. Avoid tendencies were evoked by getting participants to assume an extending position, by placing the palm on the top of a table and exerting slight pressure. Participants were then presented with neutral Chinese ideographs. In the explicit evaluation experiment, participants had to judge whether they liked each ideograph as it was presented. In the automatic version, participants had to make a non-evaluative judgment (whether the ideograph was simple or complex). In both experiments, participants then had to rate the ideographs on a pleasant-unpleasant continuum. Results have shown that participants produce more positive evaluations whilst flexing than extending, and more negative evaluations whilst extending than whilst flexing, but only for the explicit judgment experiment. No effects were found for the automatic experiment. From this it has been concluded that flexing and extending have an effect on attitudes through motivational orientations of approach and avoid.

These conclusions may not be sound. If automatic evaluation does not predispose for flexing and extending then it seems odd to assume that flexing will produce approach tendencies and extending will produce avoid tendencies. Clearly flexing and extending did affect subsequent attitudes, but there is no direct evidence

that this works through approach and avoid motivations. There is not a clear alternative explanation for why flexing should make people evaluate things more favourably than extending; most of these studies have tested for possibilities such as flexing being more pleasant than extending, or flexing producing more pleasant feelings than extending, but these have been ruled out as determining factors for these particular studies.

There is also more recent research that is based on the research by Cacioppo et al (1993) and Chen and Bargh (1999), and the claim that flexing is an approach movement and extending is an avoid movement. This research has examined the effects of flexing and extending on problem solving and creativity, and has shown a link between these motor positions and subsequent performance on certain problem solving tasks. Specifically, they have shown that participants who assume a flexing position solve problems more quickly, and generate more creative solutions, than participants who assume an extending position (Friedman and Forster, 2002). Other studies have shown that flexing increases food intake relative to extending, (Forster, 2003). These studies are attempting to use flex and extend arm positions to tap into approach and avoid tendencies and their motivational states of promotion and prevention. Their conclusions and theories are based on approach and avoid motivational states, i.e. that when participants flex they are in an approach, or promotion, state of motivation and will therefore adopt a more risky strategy, thus leading to increased problem solving ability and increased food intake. When participants extend they are in an avoid, or prevention, motivational state and will therefore adopt a less risky strategy which will lead to decreased problem solving ability and decreased food intake relative to the flex group. There are clearly links between flex and extend arm positions and subsequent behaviour ranging from

evaluations, attitudes, problem solving, and food intake, but the finding that automatic evaluation is not linked to approach and avoid tendencies casts some doubt as to whether flexing does indeed evoke any approach motivations or extending any avoid motivations.

The flex and extend argument has also grown more complex with a recent study from Cretenet and Dru (2004). They too used flex and extend positions to induce motivational states, but they examined bilateral positions as well as the unilateral ones seen in previous research. Using the idea that the motivational systems are lateralized and independent, with approach systems being based in the left hemisphere, and avoid motivations based in the right hemisphere (Davidson et al, 1990), they extended previous studies that have simply used flexing and extending in the right arm. They theorized that flexing on the right would activate the left approach system, and extending on the left would activate the right withdrawal system. Firstly they explored the evaluative consequences of performing the flex and extend motor positions using unilateral positions with both the left and right arms. There were two competing hypotheses. Firstly one could argue that the effects of motor actions and laterality would be additive. Thus performing a right arm flexion (activating approach) would lead to very positive evaluative reports, and a left arm extension (activating avoid) would lead to very negative evaluative reports, whilst right arm extension and left arm flexion would lead to neutral reports as the motor action may cancel out the influence of laterality. This is the valence hypothesis.

Alternatively one could argue that a congruent phenomenon might occur. So right arm flexion could lead to very positive evaluative reports, because the flexion induces approach tendencies and a motor action on the right also induces approach tendencies in the left hemisphere. Similarly a left arm extension could also produce

very positive evaluative reports because once again the two variables are in the same direction; the extension induces withdrawal tendencies and the motor action on the left also induces withdrawal tendencies in the right hemisphere. A right sided extension and a left sided flexion would produce very negative evaluative reports because the two variables are incongruent with one another; for example the right sided extension produces withdrawal tendencies from the extension but approach tendencies from the right sided motor action. This is the congruence hypotheses.

So in study 1 participants performed left or right sided flexion or extension whilst rating neutral Chinese ideographs, and these conditions were compared to control ratings made before the main experiment whilst performing no motor action. Results showed that judgments were more positive whilst performing left side extension and right side flexion than in the control condition. Judgments were more negative when performing right side extension and left side flexion than in the control condition. This is consistent with the congruence hypothesis. Congruent conditions where the motor action and action side matched (such as the right side flexion where the flexion induces approach tendencies and right side motor action activates left side approach tendencies) produced more positive evaluations than the control condition. Incongruent conditions where the motor action and action side did not match (such as left sided flexion where the flexion induces approach tendencies but the left side motor action activates right side withdrawal tendencies) produced more negative evaluations than the control condition.

In their Experiment 2, Cretenet and Dru (2004) used bilateral arm positions to examine the congruence hypothesis further. They postulated that performing the two congruent actions together would produce extremely positive evaluations, but that performing the two incongruent actions would produce extremely negative

evaluations. Results confirmed these predictions; participants in the bilateral congruent condition gave more positive evaluations, and participants in the bilateral incongruent condition gave more negative evaluations. Thus these experiments provide support for the congruence hypothesis. But Cretenet and Dru's hypotheses, study, and conclusions, rely heavily on the argument that flexing evokes approach motivations and extending evokes avoid motivations. Once again it is clear that these flex and extend positions do affect subsequent evaluations, but the underlying functions producing these effects may not be linked to approaching and avoiding. Cretenet and Dru are tentative in their conclusions and suggest further research to replicate results supporting the congruence hypothesis. For all the research described in this area, direct evidence, showing that approach and avoid tendencies are indeed produced upon flexion and extension, is needed in order to definitively conclude that the link between these motor actions and subsequent evaluation is produced through motivational states.

In addition if automatic affective evaluation does not predispose for arm flexion and extension, and therefore approaching and avoiding, then the purpose of automatic affective evaluation still remains unclear and might be an interesting avenue for future research.

If flexing and extending are not linked to automatic evaluation then perhaps they are not rigidly linked to explicit evaluation either. Clearly there is a link between explicit evaluation and approaching and avoiding, but this may not just be specifically flexing and extending. In their discussion Rotteveel and Phaf (2004) suggest that if the evaluation behaviour link depends upon conscious evaluation and deliberative thought, then it is likely that situational factors influence which behaviours are prepared. My experiments use a paradigm that requires participants to reach out

towards the screen, and therefore extend their arms, for both approaching and avoiding. Therefore I have produced a congruency effect that is not linked in a straightforward way to flexing and extending. It seems possible that explicit evaluation may not be rigidly linked to flexing and extending, but instead linked to whatever behaviour causes an appropriate approach or avoid outcome. The purpose of the next chapter is to directly test whether situational factors can influence the type of approach/avoid behaviour that is prepared.

Chapter 5.

Predispositions to Approach and Avoid are not just Valence Specific Motor Responses but Actions that Produce the Desired Environmental Effect.

The fundamental question facing any cognitive agent might be the decision of whether to approach or avoid. It can be life-threatening to approach a dangerous object, yet equally maladaptive to avoid beneficial ones. We might then expect cognitive agents to have sophisticated mechanisms for evaluating stimuli, and for initiating appropriate approach and avoid responses. It is therefore surprising that previous research suggests very unsophisticated approach and avoid responses. For example, the avoid response in a frog consists primarily, or exclusively, of leaping to where it is darker (Lettvin, Maturana, McCulloch, and Pitts, 1959).

Previous research has suggested that people likewise have predispositions to respond in specific ways to valenced stimuli. Chen and Bargh (1999) found that when participants were asked to judge the valence (pleasant or unpleasant) of a word and then respond by using a lever, participants were faster to pull in response to pleasant words, and to push in response to unpleasant words. Chen and Bargh (1999; see also Solarz 1960, Cacioppo et al 1993, Forster and Strack, 1996) argued that people have a predisposition to approach positive items by pulling them closer, and to avoid negative ones by pushing them away. That is, the evaluation of the stimulus is automatically associated with a specific muscle response: flexing a bicep is usually an approach movement, and extending the tricep is usually an avoid movement.

However, at the level of the effectors, no single set of responses can be appropriate for every situation. In some cases when encountering an unpleasant

stimulus, like a spider, you would be unlikely to reach out and try to push it away. You would be more likely to jump back and flex your muscles away from it. Similarly, when encountering a pleasant object, like a pizza, the first response you need in order to get it is to extend your arm to reach it and pick it up; the flexing comes later. It seems as if the appropriate initial response of flexing or extending to pleasant and unpleasant stimuli depends on situational demands. So if a pleasant stimulus predisposed us to flex our muscles and draw something towards us, then in a situation in which an extended reach was first necessary, the predisposition would have to be overridden. This would at least cause a delay and would defeat the value of automatic predispositions to behaviour. Here we ask whether approach and avoid responses in humans are highly specified, as argued elsewhere (Chen and Bargh 1999, Solarz 1960, Duckworth et al 2002), or whether situational factors exert a strong influence on which behaviour is activated.

In many papers that investigate how the evaluation of valenced stimuli affects subsequent flex and extend movements, the authors admit that there may be situations in which context could influence or change the behaviours that are associated with approaching and avoiding valenced stimuli, even while arguing for highly specific response activations. For example, Chen and Bargh (1999) state "it may be possible to generate quite different effects within the same paradigm....different social situations call for different responses....although the scope of the current experiments is not designed to address these issues they are necessary avenues for future research". Clore and Ortony (2000) also argued for a dissociation between appraisal and specific behaviours. And recently Rotteveel and Phaf (2004) showed that tendencies for arm flexion and extension are not automatic consequences of automatic affective evaluation. They did, however, find a link between explicit evaluation and

arm flexion and extension, and they discuss this with relation to the possible effect of situated meaning. They suggest that "if action tendencies for arm flexion and extension depend on conscious appraisals, the situated meaning and context for these movements would be incorporated into these processes'. However, in none of these reports were there any direct tests of whether approach and avoid responses are modulated by contextual factors.

The only previous demonstration of contextual effects I am aware of is from Markman and Brendl (2005), who investigated the effects of self-representation on approach and avoid actions. They separated the location of the body from a representation of the self, provided by a participant's surname. They found that approach and avoid responses were based more upon the location of the surname than the location of the body. However, it is unclear from this demonstration whether this phenomenon is specific to self-representation or whether the effect is more general than this and that any change in participants' understanding of the meaning of their responses could change which behaviour is predominately prepared.

Thus, we have a situation in which there is a good deal of evidence for specific links between appraisal and activated responses (e.g., approach = bicep contraction), yet a general recognition that such specific links would not be appropriate in many cases. This chapter tests the hypothesis that links between stimulus appraisal and automatic response activation are sensitive to current contextual factors. This would be consistent with the literature reviewed in Chapter 2 that demonstrated that semantics play a strong role in the link between evaluation and subsequent response (De Houwer et al, 2001; De Houwer and Randell, 2004; Storbeck and Robinson, 2004). Thus, this chapter investigates the role of situational effects on the link between explicit evaluation of objects and subsequent approach and avoid behaviour,

and provides the first direct demonstration of a non-spatial response effect influencing which approach and avoid behaviours are prepared.

Experiment 1

In the explicit evaluation experiment in Chapter 3, a valenced and a neutral object were presented and participants were asked to touch one of the objects based on the evaluation of the valenced object as either positive or negative. Both approach and avoid responses therefore required a similar movement of reaching out to touch the screen. Importantly, this experiment demonstrated that approach and avoid effects can be observed even when gross muscle movements for the two responses are very similar. These results suggest that the evaluation of a stimulus as positive or negative may not generate a specific pattern of muscle responses (e.g. biceps contraction), but a more abstract response. Perhaps upon encountering a valenced object the behaviours needed to approach and avoid are rapidly determined for that situation. These behaviours are then more easily and quickly executed due to the strong predisposition to approach pleasant objects and avoid unpleasant objects.

In order to test this, the same physical response needs to be associated with two different outcomes: one in which the valenced object approaches the participant, and one in which it moves away from the participant. To do this, the previous paradigm was extended, so that responses included one of two possible consequences following the touch of an object on the touchscreen. First, in the "Towards" conditions, the touched object increased in size (as if approaching), and the untouched one shrank (as if moving away). Alternatively, in the "Away" conditions, the consequences were reversed: the touched object shrank (as if being pushed away) and

the untouched one increased in size. This consequence of responding, or the *Response Effect,* therefore changes the semantics of the response, without changing the physical response itself. This means that "approach" and "avoid" actions, in which physically identical responses are made to physically identical stimuli, can be compared. See Figure 5.1.

In the Towards condition, the expectation is that the normal congruency effect will occur, as the Response Effect matches the response made. But, in the Away condition the Response Effect, and the changed meaning of the response, will reverse the normal congruency effect. Such an outcome would show that situational factors are important in the link between stimulus evaluation and subsequent approach-avoid behaviour. But, if the congruency effect does not differ as a function of Response Effect, it suggests that the predisposition to respond to positive and negative stimuli is fairly rigid and does not take situational effects into account.

Method

Participants. Twenty-four undergraduates (22 female) participated for course credit. All were right handed, native English speakers, had normal vision, normal hearing, and no neurological problems. All gave informed consent and were debriefed after the experiment.

Stimuli. Stimuli were the same as in the explicit evaluation experiment (Experiment 1, Chapter 3.

Design. The design was identical to Experiment 1, Chapter 3, with the added between subjects factor of Response Effect (Towards or Away).

Procedure. The procedure was the same as Experiment 1, Chapter 3, with one exception. When a response was made one of two effects now occurred depending on which version of the experiment the participant was doing. In the Towards version,

whichever stimulus (Picture/Word or square) that the participant touched got larger and seemed to get closer to them. So if they touched the Picture/Word it became larger, and the square became smaller. If they touched the square, the square became larger, and the Picture/Word became smaller. In the Away version whichever stimuli the participant touched got smaller and seemed to be pushed away from them. So if they touched the Picture/Word it got smaller, and the square got bigger, and if they touched the square it got smaller, and the Picture/Word got bigger (Figure 5.1). Animation of the untouched image was vital to the design of the experiment; for example, when participants touched the neutral stimulus, and it changed in size, importantly, there was also an effect on the valenced stimulus making it get smaller in the towards condition and bigger in the away condition. This design also allowed identical animations for different responses. For example, the Approach Towards condition would have the same animation as the Avoid Away condition.

The size changes occurred immediately after the participant's response. Details of the size changes are as follows: Stimuli started as 8x8cm. They either increased in size to 12x12cm, or decreased in size to 2.7x2.7cm.

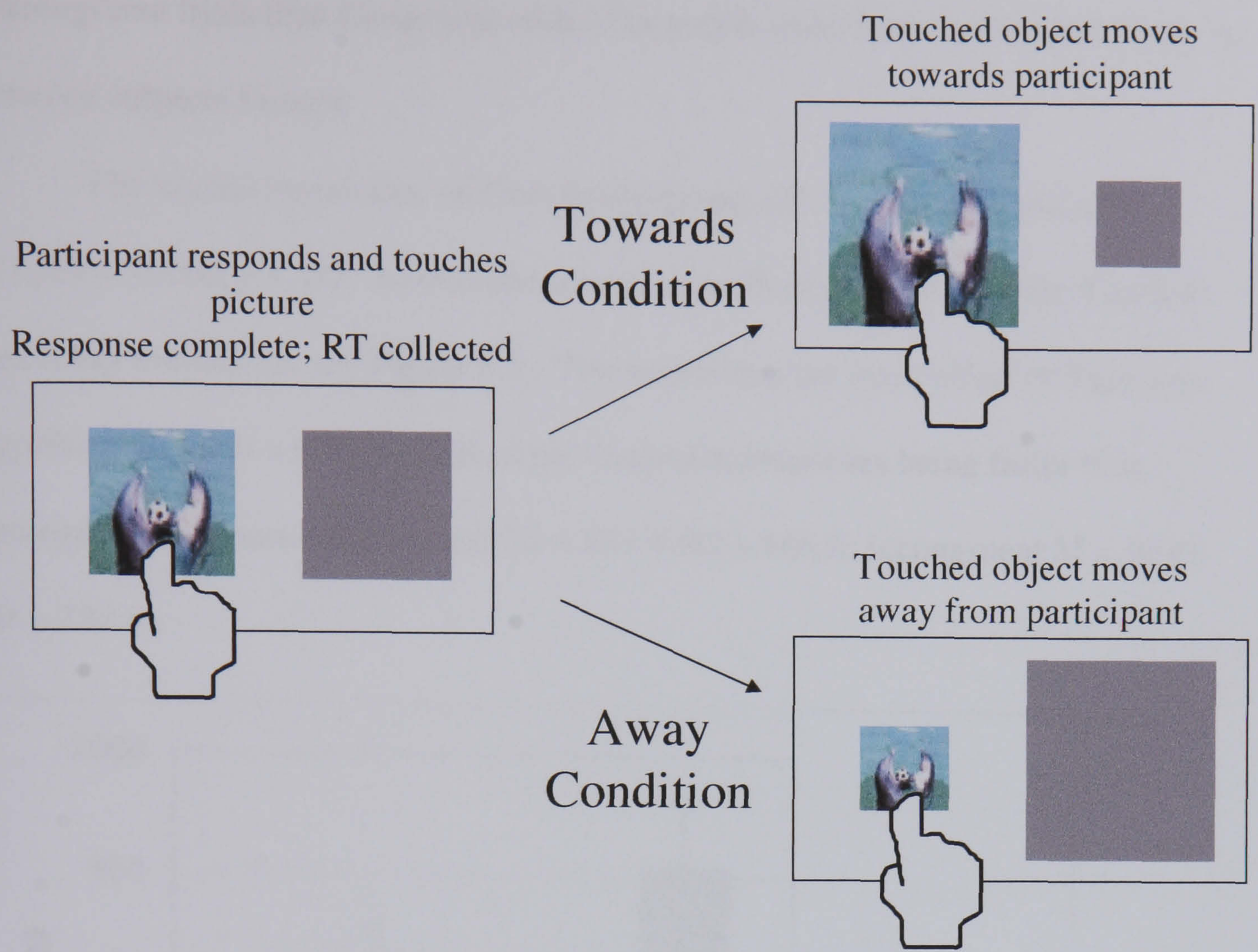

Figure 5.1. Illustration depicting the Response Effect in the Towards and Away conditions.

Results

Response times were calculated as in Experiment 1, Chapter 3. Prior to analysis, responses times were iteratively trimmed to include responses within 3 standard deviations of the mean for each participant and each condition. An ANOVA was conducted with Side (Left/Right), Valence (Pleasant/Unpleasant), Task (Congruent = approach pleasant items or avoid unpleasant items / Incongruent = approach unpleasant items or avoid pleasant items) and Stimulus Type (Word/Picture) as within subjects factors, and Response Effect (Towards or Away) and Order

(Incongruent trials then Congruent trials/ Congruent trials then Incongruent trials) as between subjects factors.

The crucial interaction of Task by Response Effect was not significant, $F(1,20) = 0.160$, $p = .69$. Instead the congruency effect held for both the Towards and Away conditions, see Figure 5.2. This meant that the main effect of Task was significant $F(1,20) = 6.23$, $p < .05$, with Congruent responses being faster than Incongruent responses. (Congruent M = 855.4 SD = 166.0, Incongruent M = 929.6 SD = 238.9).

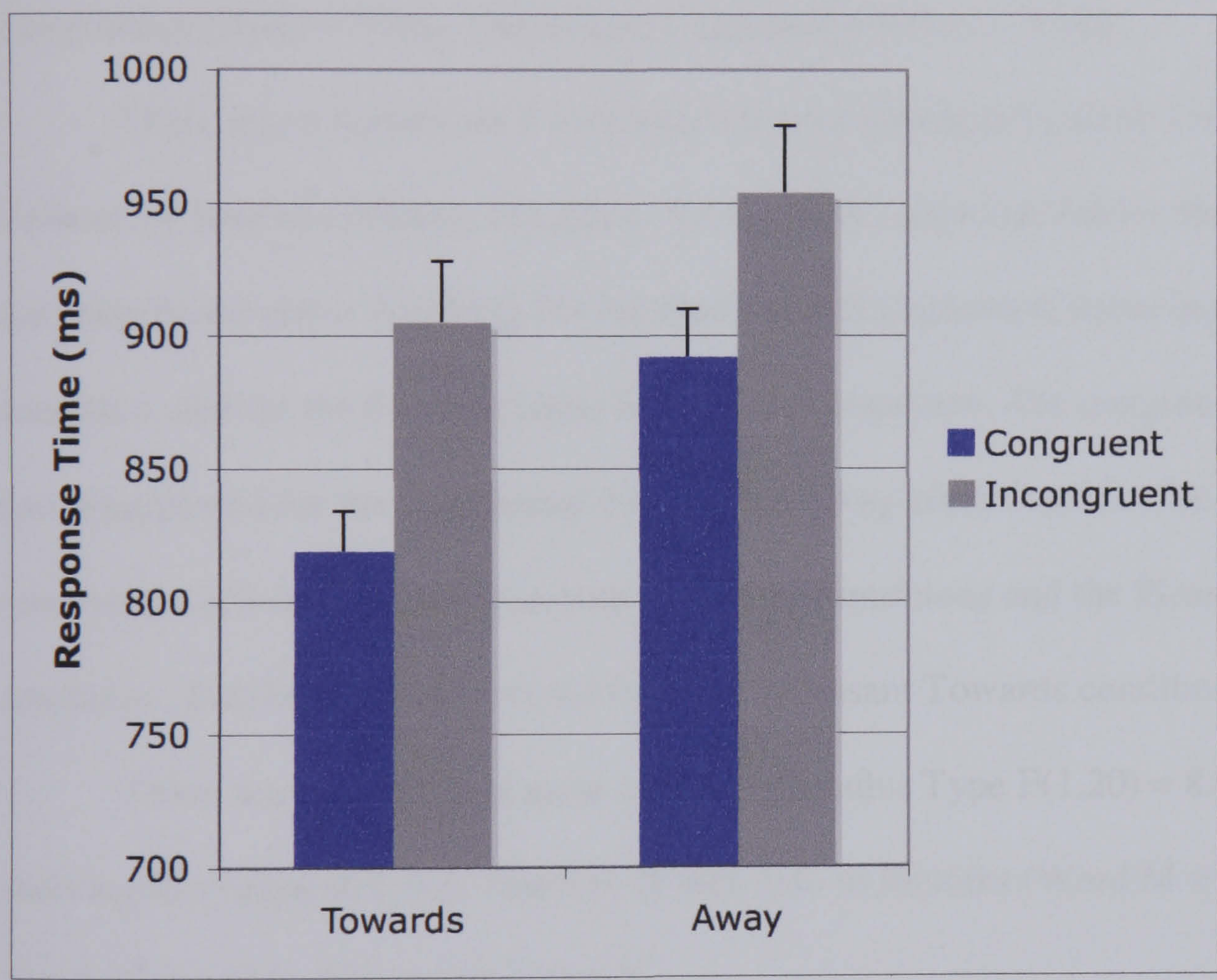

Figure 5.2. Mean Response Times in milliseconds for Congruent and Incongruent responses for both Towards and Away conditions.

There was a significant interaction of Task by Valence $F(1,20) = 9.48$, $p < .05$, showing that participants were faster to approach than avoid the stimuli, (Approach M = 877, SD = 209, Avoid M = 908, SD = 208)

There was a significant interaction of Side by Valence by Task $F(1,20) = 10.08$, $p = .005$, showing that the congruency effect for Pleasant items on the Right was much larger than for Unpleasant items on the Right (Pleasant Congruency Effect = 132ms, Unpleasant Congruency Effect = 36ms) whereas on the Left the congruency effect for Pleasant items and Unpleasant items was more similar (Pleasant Congruency Effect = 77ms, Unpleasant Congruency Effect = 51ms).

There was a significant 4 way interaction of Stimulus Type by Task by Valence by Response Effect, $F(1,20) = 5.85$, $p < .05$, showing that for the Pictures the congruency effect was large for the Pleasant and Unpleasant items in the Towards condition, and for the Pleasant items in the Away condition. The congruency effect had disappeared for the Unpleasant items in the Away condition. For the Words the congruency effect was present in both the Away Conditions and the Pleasant Towards condition. Bizarrely it had reversed for the Unpleasant Towards condition.

There was a significant main effect of Stimulus Type $F(1,20) = 8.89$, $p < .01$, showing that responses were faster to Words than to Pictures (Word M = 857.5 SD = 177.2, Picture M = 927.5, SD = 231.4).

Again there was a significant interaction of Task by Order $F(1,20) = 23.48$, $p < .001$, showing that participants are faster on the second block suggesting improvement with practice.

There were no other significant effects.

Discussion

The results revealed that the Response Effect did not influence the Congruency Effect. The Congruency Effect remained in the original direction for both the Towards and Away conditions. Thus, the results were very similar to the results in the Explicit Evaluation Experiment in Chapter 3. This could mean that the predisposition to respond to positive and negative stimuli is fairly rigid and does not take situational effects into account. But I believe that the participants understanding of the situation is the key to which approach and avoid responses are prepared, faster, and therefore responsible for, producing the congruency effect. If participants in this experiment did not really pay attention to, or realize the importance of, the Response Effects, then this could be one reason why the Response Effect did not influence the Congruency Effect. Participants were instructed to touch or not touch the stimuli, so this may have been in the forefront of their minds, rather than the situational understanding that in the Away conditions they were actually pushing something away by touching it. Thus the experiment was rerun but with a modification of the instructions to emphasize the importance of the Response Effects.

Experiment 2

Method

Participants. Twenty-four undergraduates (21 female) participated for course credit. All were right handed, native English speakers, had normal vision, normal hearing, and no neurological problems. All gave informed consent and were debriefed after the experiment.

Stimuli. The stimuli were identical to those in the previous experiment.

Procedure. The procedure was the same as in the previous experiment with one exception. In this experiment the experimenter made sure the participants were aware of the Response Effects in the different conditions by modifying the instructions. So in the Away condition, participants were now asked to *push* the stimuli away, or to *push* the square away, highlighting the consequence of their response. In the Towards condition participants were still asked to *touch* the stimuli.

So in the Towards version the instructions were the same as in the previous experiment; in the Congruent task participants were instructed to "touch the Picture/Word if you like it, and touch the square if you do not like the Picture/Word." In the Incongruent task participants were instructed to "touch the Picture/Word if you do not like it, and touch the square if you do like the Picture/Word." Participants were also told that when they touched something it would get bigger and the other item would get smaller.

In the Away condition participants in the Congruent condition were instructed to "Push the Picture/Word away if you like it, and push the square away if you do not like the Picture/Word". In the Incongruent condition participants were instructed to "Push the Picture/Word away if you do not like it, and push the square away if you do like the Picture/Word". Participants were also told that when they pushed something away it would get smaller and the other item would get bigger.

Results

Response times were calculated as in Experiment 1. Prior to analysis, responses times were iteratively trimmed to include responses within 3 standard deviations of the mean for each participant and each condition. An ANOVA was conducted with Side (Left/Right), Valence (Pleasant/Unpleasant), Task (Congruent =

approach pleasant items or avoid unpleasant items / Incongruent = approach unpleasant items or avoid pleasant items) and Stimulus Type (Word/Picture) as within subjects factors, and Response Effect (Towards or Away) and Order (Incongruent trials then Congruent trials/ Congruent trials then Incongruent trials) as between subjects factors.

The important interaction of Task by Response Effect was significant, $F(1,20) = 8.91$, $p = .007$ The congruency effect remained for the Towards version but reversed for the Away version (Towards: Congruent M = 819.1ms, SD = 144.5, Incongruent M = 905.2ms, SD = 230. Away: Congruent M = 1068.3ms, SD = 272.4 Incongruent M = 949.5ms, SD = 158). See Figure 5.3.

Figure 5.3. Mean Response Times in milliseconds for Congruent and Incongruent responses for both Towards and Away conditions.

The main effect of Task was not significant, $F(1,20) = 0.23$, $p = .639$

Beyond the theoretically crucial interaction of Task by Response Effect, there were a number of other significant effects, which do not particularly bear on the hypotheses.

The interaction of Task by Order was significant, $F(1,20) = 8.78$, $p = .008$, reflecting the fact that participants' reaction times were usually faster on the second block.

The main effect of Response Effect was significant, $F(1,20) = 6.019$, $p = .023$, reflecting that participants were faster to respond in the Towards condition, M = 862.2ms, SD = 196.4, (where the response and response effect matched) than in the Away condition, M = 1008.9ms, SD = 230, (where the response and response effect did not match).

The interaction of Task by Valence was significant, $F(1,20) = 7.02$, $p = .015$. This showed that, averaged over the Towards and Away conditions, trials on which participants approached the item (congruent pleasant and incongruent unpleasant) were responded to faster, Approach M = 924, SD = 217, than trials on which participants avoided the item (congruent unpleasant and incongruent pleasant), Avoid M = 947, SD = 235.

There were no other significant effects.

Discussion

The results of Experiment 2 revealed that following evaluation the predisposition to respond can be affected by consequences of the physical action and is not necessarily an inflexible valence-specific physical response. To review this crucial finding, recall that in the Towards version of the task, the Response Effect was

consistent with the response. For example, when participants responded by touching an item, the effect of the response was that the item then "approached" them. As in the explicit evaluation experiment (Experiment 1, Chapter 3), participants in the Towards version were faster on the Congruent trials than on the Incongruent trials. In the Away version, the Response Effect was inconsistent with the response. Now, for example, when participants responded by touching an item, the effect was that the item was "pushed away", and so avoided. In the Away conditions, the congruency effect was reversed. Comparing Towards and Away conditions, it is clear that what was crucial was not the physical response (e.g. touching), but the effect that the participant understood the response had (bringing the stimulus closer or further away). This demonstrates that approach and avoid responses generated in response to evaluating a stimulus are not fixed and inflexible, but vary with situational factors, most importantly the participants understanding of the situation.

Experiment 3

In Experiment 2, a spatial effect was used to signify that the valenced stimuli were approaching or avoiding the participant. Experiment 3, was designed to show that adding a non-spatial Response Effect could reverse the expected congruency effect, just as the spatial effect did in Experiment 2. That is, are the links between stimulus appraisal and response activation limited to the effects of increasing or decreasing the distance between the viewer and the stimulus? Or might appraisal activate responses that could change the stimulus in some other desirable way?

Specifically, participants were now required to approach and avoid happy and angry faces. The non-spatial Response Effect was a change in the expression of the face coupled with a noise. There was a desirable outcome - faces become

happy/happier and were paired with a pleasant tone. And there was an undesirable outcome - faces become angry/angrier and were paired with an unpleasant tone. The prediction was that response times on Congruent trials (approach happy/avoid angry) paired with a desirable outcome would be faster than on Incongruent trials (approach angry/avoid happy) paired with an undesirable outcome. But that response times on Congruent trials paired with an undesirable outcome would be slower than on Incongruent trials paired with a desirable outcome. The Response Effect would influence which behaviours would be prepared and therefore faster, rather than specific flex and extend movements linked to each valence.

Method

Participants. 12 undergraduates (9 female) participated for course credit. All were right handed, native English speakers, had normal vision, normal hearing, and no neurological problems. All gave informed consent and were debriefed after the experiment.

Stimuli. Visual Stimuli were taken from the Calder faces set, (Calder et al, 2000). Four male faces and four female faces were used. Sound stimuli were as follows: The pleasant tone was a chime – an interval of a perfect fourth, tonic at 440hz. The unpleasant tone was a buzz – simultaneous square waves at 196 and 415hz. Each tone sounded for approximately 150ms.

Stimuli were presented on an Elo touch systems monitor controlled by an Apple Macintosh computer. Stimuli were presented on either the left side or right side of the screen 232mm from the centre. Participants were seated approximately 50cm from the screen.

Design. The task employed in this experiment lead to a mixed design with within-subjects factors of Valence (Happy/Angry), Task (Congruent = approach happy faces or avoid angry faces / Incongruent = approach angry faces or avoid happy faces) and Response Effect (Valid = response and response effect match. Invalid = response and response effect do not match). The dependent variable was Total Time to release button and touch the screen.

Procedure. A white fixation-cross (font size 24) was presented in the centre of a grey background. Participants started each trial by pressing down the large key on the keypad and keeping it held down. Immediately, an emotional face (happy or angry) appeared on one side of the screen and a neutral face (of the same person) appeared on the other side of the screen. After 300ms there was a tone from the speaker indicating that the participant could now let go of the key and respond by touching the screen. In this experiment, if the participants released the key before the tone there was an error message on the screen telling the participant that they had released too early. They then had to wait for a 5 second countdown before they could respond to that trial. These trials were discarded.

This time the instructions were to always touch the emotional face (Approach condition) or to always touch the neutral face (Avoid condition). No mention of approaching or avoiding was made.

When the participants made the response there were two effects – a change in facial expression and an accompanying noise (see Figure 4 for an example). This led to four different within subjects conditions:

In the Approach Valid condition when participants touched the happy faces the face became happier and was accompanied by a pleasant tone (the chime), when

they touched the angry faces the face became angrier and was accompanied by an unpleasant tone (the buzz).

In the Avoid Valid condition when participants avoided a happy face, by touching the neutral face, the face got angrier and was accompanied by an unpleasant tone. When participants avoided an angry face, by touching the neutral face, the face got happier and was accompanied by a pleasant tone.

So in these Valid conditions the response and Response Effects match – when approaching happy faces and avoiding angry faces, the Congruent conditions, there is a desirable effect – the faces get happier and the tones are pleasant. When approaching angry faces and avoiding happy faces, the Incongruent conditions, there is an undesirable effect – the faces get angrier and the tones are unpleasant.

In the Approach Invalid condition when participants touched the happy faces the face became angrier and was accompanied by an unpleasant tone, when they touched the angry faces the face became happier and was accompanied by a pleasant tone.

In the Avoid Invalid conditions when participants avoided a happy face, by touching the neutral face, the face got happier and was accompanied by a pleasant tone. When participants avoided an angry face, by touching the neutral face, the face got angrier and was accompanied by an unpleasant tone.

So in these Invalid conditions the response and Response Effects do not match – when approaching happy faces and avoiding angry faces, the Congruent conditions, there is an undesirable effect – the faces get angrier and the tones are unpleasant. When approaching angry faces and avoiding happy faces, the Incongruent conditions, there is a desirable effect – the faces get happier and the tones are pleasant.

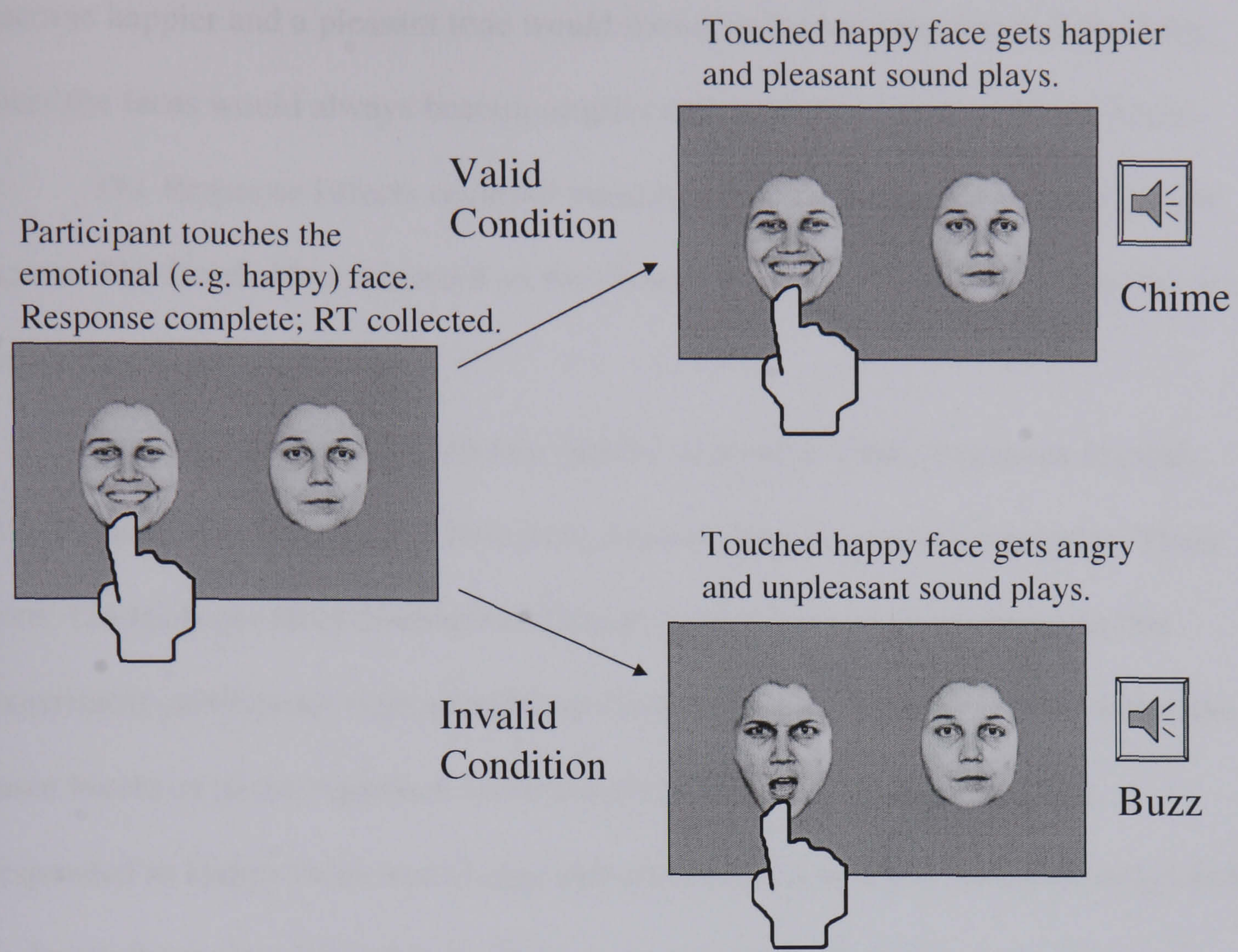

Figure 5.4. A diagram showing the consequences of responding in the Approach condition for Happy faces. Participants have approached the Happy face, a Congruent movement. In the Valid condition they gain desirable consequences – the face gets happier and a pleasant tone sounds. In the Invalid condition they get undesirable consequences – the face gets angry and an unpleasant tone sounds.

As in Experiment 2, the Response Effects were made clear to the participant. Participants were told that the effects that occurred on each trial were fixed and predictable, and that they would be able to tell what effect would occur before making the response. Before each block, participants were told the effects that would occur for responses to Happy and Angry faces. For example, on the Approach Valid trails participants were told that when they touched the Happy faces they would always

become happier and a pleasant tone would sound, and when they touched the Angry faces the faces would always become angrier and an unpleasant tone would sound.

The Response Effects occurred immediately after the participant touched the screen. The facial effect remained on the screen for 500ms. The fixation-cross for the next trial was then presented.

Participants completed all four blocks: Approach Valid, Approach Invalid, Avoid Valid, Avoid Invalid. These were counterbalanced across participants. There were 128 trials per block leading to 512 trials in total for each participant. In this experiment participants were completing Congruent and Incongruent trials within the same block; so in the Approach Valid condition trials on which participants responded to Happy faces were Congruent and those on which participants responded to Angry faces were Incongruent. These were separated out for the analysis. So, for example the Happy trials in the Approach Valid condition were taken along with the Angry trials in the Avoid Valid condition, these were all then Congruent Valid trials. The blocks were separated in this manner to create Congruent Valid, Incongruent Valid, Congruent Invalid, and Incongruent Invalid trials for the analysis.

Results

Response times were calculated as in Experiment 1. RT distributions were iteratively trimmed to include scores within 3 standard deviations of the mean, for each condition and for each participant. An ANOVA was conducted with Valence (Angry/Happy), Task (Congruent = approach happy faces and avoid angry faces / Incongruent = approach angry faces and avoid happy faces) and Response Effect (Valid/Invalid) as within subjects factors.

The important interaction of Task by Response Effect was significant, $F(1,11) = 6.21$, $p = .03$. The congruency effect remained for the Valid conditions but reversed

for the Invalid conditions (Valid: Congruent M = 728.5, SD = 150, Incongruent M = 756.4, SD = 160.5. Invalid: Congruent M = 734.3, SD = 180, Incongruent M = 707.8, SD = 148). See Figure 5.5.

So in the Valid conditions the Response Effect was consistent with the response. So participants completed Congruent trials with desirable consequences and completed Incongruent trials with undesirable consequences. Response times in the Valid conditions were faster on the Congruent trials than on the Incongruent trials.

In the Invalid conditions the Response Effect was inconsistent with the response. So participants completed Congruent trials with undesirable consequences and completed Incongruent trials with desirable consequences. Participants in the Invalid conditions were faster on the Incongruent trials than on the Congruent trials.

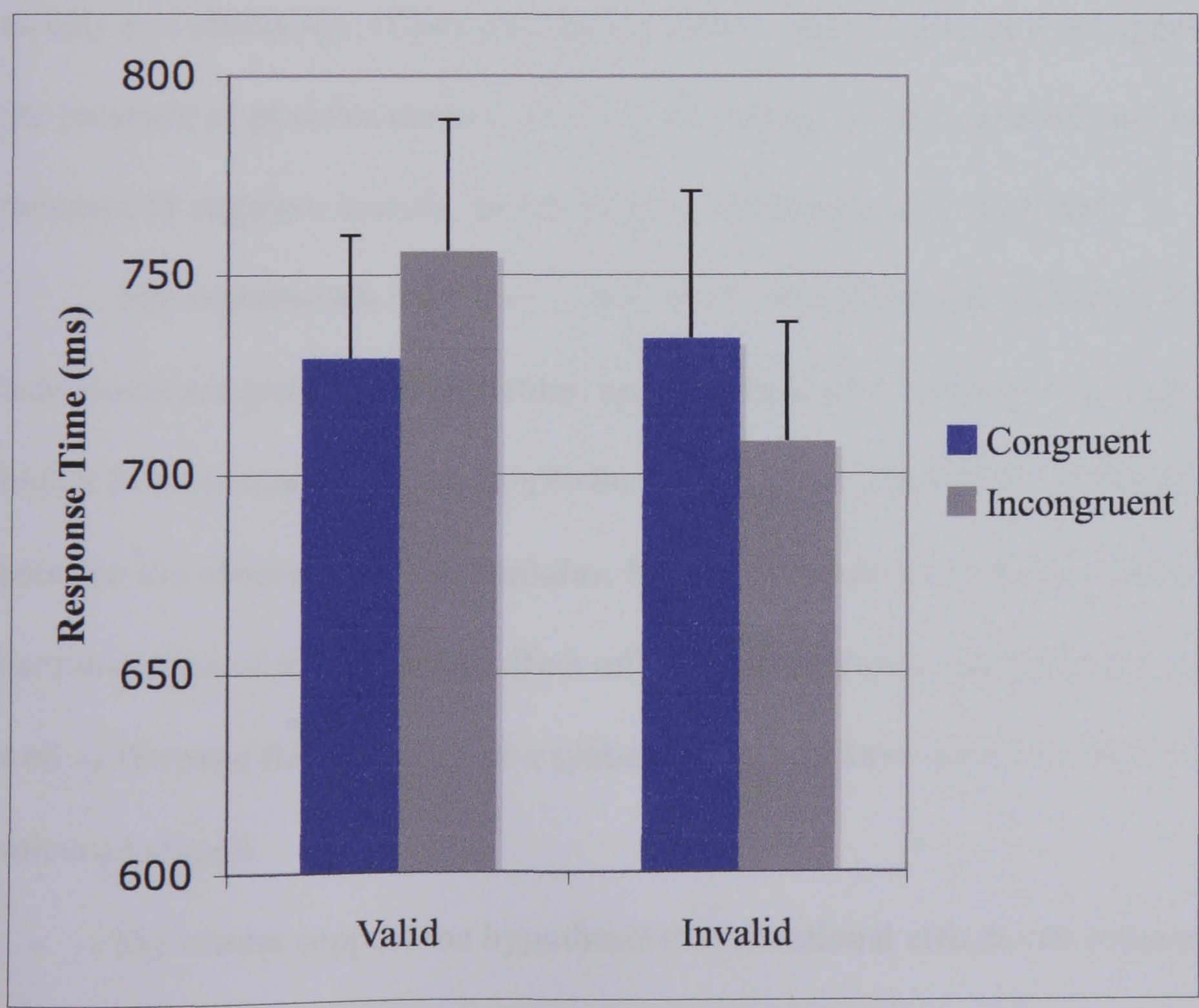

Figure 5.5. Mean Response Times in milliseconds for Congruent and Incongruent responses for both Valid and Invalid conditions.

The main effect of Valence was significant, $F(1,11) = 10.92$, $p < .01$. Participants were faster to respond to the Happy faces than to the Angry faces (Happy M = 714ms, SD = 157.8, Angry M = 750ms, SD = 158.8).

The main effect of Task was not significant, $F(1,11) = 0.005$, $p = .946$, (Congruent M = 731ms, SD = 163, Incongruent M = 732ms, SD = 154.7).

There were no other significant effects.

Discussion

It has been hypothesized that evaluation of an item as positive or negative primes particular muscles and behaviours so that these behaviours can be executed rapidly and efficiently, (Chen and Bargh, 1999). Specifically, it was suggested that in the presence of positive stimuli, a flexing or pulling action is primed, and in the presence of negative stimuli, an extending or pushing action is primed.

My experiments have shown that situational effects can influence which behaviours are primed. In particular, approach and avoid responses are activated in a highly flexible manner; according to the way they will change the relationship between the observer and the stimulus. My experiments have provided the first demonstration of a non-spatial effect influencing approach and avoid behaviours, as well as showing the influence of a spatial effect, and have done so with a variety of valenced stimuli.

My results support the hypothesis that situational effects can influence the approach/avoid behaviours that follow explicit affective evaluation. In the Explicit Evaluation Experiment in Chapter 3 the large congruency effect found by Chen and

Bargh (1999) was replicated. The congruency effect showed that in an explicit affective judgment task participants were faster to approach pleasant and avoid unpleasant stimuli than they were to approach unpleasant and avoid pleasant stimuli. This shows that the large effects found by Chen and Bargh (1999) in an explicit evaluation task can easily be replicated using a different paradigm. But although the congruency effect was replicated, it is important to note that in both the act of approaching, and the act of avoiding, arm extension was the predominant movement. This result suggests that there is more to the phenomenon than simple motor movements linked with valence, but clearly a further experiment was needed to test this directly. Experiment 1 was designed for this purpose.

Experiment 1 failed to show that the Response Effect could influence the congruency effect. I suggested that this null effect may have occurred because the participants had not really paid attention to, or noticed the importance of the response effect, as the instructions still placed the emphasis on touching or not touching the stimulus. In Experiment 2, Experiment 1 was rerun, but with modified instructions that emphasized the meaning and importance of the Response Effect.

The results of Experiment 2 showed that the congruency effect could be reversed if participants' understanding of the situation changed. If participants believed that by touching (approaching) a valenced stimulus they were pushing it away, and by touching a neutral stimulus (avoiding the valenced stimulus) they were causing the valenced stimulus to become closer to them, then the usual congruency effect reverses. The action of the participant is not important - only the intended consequence that they are causing the valenced stimuli to move away or get nearer. It seems that the actions that will cause positive items to become closer, and negative

items to move away, are primed upon initial evaluation and therefore executed more rapidly.

Experiment 3 showed that the congruency effect reversed with the addition of a non-spatial response effect. The actual movement of the participant towards the happy and angry faces was not important, only whether the movement produced a desirable outcome. So participants would be faster to approach faces that became happy and were paired with a desirable tone, than to approach faces that became angry and were paired with an undesirable tone, regardless of whether they were approaching a happy or an angry face to begin with. Similarly participants were faster to avoid faces that became angry and were paired with an undesirable tone, than faces that became happy and were paired with a desirable tone, regardless of whether they were avoiding a happy or an angry face to begin with. This shows a good degree of flexibility in the responses that are prepared. The participant quickly learns which behaviours will produce the desired outcome and then these behaviours are primed upon evaluation leading to a speeded response.

In Experiment 3 there were slower responses in the conditions that have the undesirable consequences. Thus it is possible that the reversal we see in the congruency effect is due to a main effect of the consequences. So, conditions that are followed by undesirable consequences are simply slower than conditions that are followed by desirable consequences. In some ways this is what we are trying to say – that the consequences are the important factor and that they become more important than any particular approach or avoid movement. Thus the consequences drive which behaviours are prepared; an undesirable consequence in a congruent condition will cause this congruent condition to become slower than an incongruent condition with desirable consequences and thus can reverse or wipe out the congruency effect.

Unfortunately because of the design of this experiment we cannot separate the main effect of consequence from the congruency effects. It may be difficult to do so in any experiment. What would be needed is a design where the desirable or undesirable consequence is neither spatial, nor inherently good or bad. This experiment is currently being planned.

Experiment 3 has implications for the demonstration by Markman and Brendl (2005), described earlier. Recall that Markman and Brendl found that approach and avoid responses were based more upon the location of the surname than the location of the body. Their study was designed to investigate the effects of self-representation and their results were explained within that domain, but they are also highly relevant to my studies.

Markman and Brendl (2005) explain that their results show that congruency effects depend upon people's representations of themselves in space rather than their physical location. My Experiment 3 has shown that the effect extends beyond the realm of self-representation, and that non-spatial consequences, that are not associated with any apparent movement towards or away from any aspect of the self, are sufficient to reverse the congruency effect. Instead the effect seems to be more general; the primed behaviours are not always simple pull or push movements but depend on more complex environmental cues that can be spatial or non-spatial. I propose that Markman and Brendl's results are a specific example of the more general effect that I have demonstrated. In their study participants understood that their responses had an effect on their surname and this influenced which movements were faster. But my experiments suggest that any change in participants understanding of the meaning of their responses, be it with respect to self representation, spatial effects

towards or away from the body, or any non-spatial desirable or undesirable consequence of responding, could change which behaviour is predominately prepared.

In the Chen and Bargh (1999) experiments, neither pushing nor pulling the lever had any effect on the valenced target object. The robust compatibility effects found by Chen and Bargh in their explicit evaluation task therefore cannot be explained by the immediate consequences of action. But it is possible that the instructions had an effect. Chen and Bargh instructed participants to "pull the lever towards yourself" in the presence of certain words and "push the lever away from yourself" in the presence of other words. Similar instructions were used in the original demonstration by Solarz (1960). Both Solarz (1960) and Chen and Bargh (1999) found that participants were faster to pull the lever when responding to positive words than when responding to negative words, and faster to push the lever when responding to negative words than when responding to positive words. If the instructions had been "pull the lever away from the word" or "push the lever towards the word" would the congruency effect have reversed? Would participants have been faster to pull in response to negative words believing they were pulling "away from the word" and faster to push in response to positive words believing they were pushing "towards the word"? Chen and Bargh entertain this idea themselves "we would not rule out the possibility that the automatic behavioural responses observed in the current studies are somehow produced by the particular instructions to the participants. A reframing of the instructions could well have produced the opposite relationship between attitude and behaviour" This is one possibility for the compatibility effects they found, and an interesting possibility for future research.

There are a few studies that have found results supporting the interaction of approach and avoid behaviors with contextual factors. In particular there is evidence

that making an approach or avoid action can affect evaluation of concurrent stimuli. Neumann and Strack (2000 experiment 3) used a concentric circle effect to give the impression of movement towards or away from a computer screen upon which words were presented. They showed that positive words were categorized more rapidly than negative words if participants had the impression that they were moving toward the computer screen, whereas negative words were categorized more rapidly than positive words if participants had the impression they were moving away from the screen. The effect is in the complementary direction to mine – apparent approaching or avoiding affects speed of evaluation.

Likewise, Brinol and Petty (2003) showed that head shaking (avoidance) and nodding (approach) affects arguments differently depending upon the social context. They showed that head nodding increased confidence, and head shaking decreased confidence, in ones own thoughts. So when participants were exposed to a strong persuasive version of an argument, and so had favourable thoughts, nodding increased persuasion and shaking reduced it. When participants were exposed to a weak argument, and so had unfavourable thoughts, nodding reduced persuasion and shaking increased it.

Again Brinol and Petty's (2003) effect is in the complementary direction to mine, demonstrating how ongoing (or recent) responses can bias stimulus evaluation. But despite the important differences between Brinol and Petty, Neumann and Strack (2000), and my experiments, in both the paradigms and focus of investigation, these studies provide support for the importance of situated meaning on evaluation and associated approach and avoid movements, and together they suggest that it can occur in a bi-directional way.

A few other results are consistent with my findings on response effects and

approach/avoid reactions. Wentura, Rothermund, and Bak (2000 Experiment 3) presented words and non-words on a computer screen, and participants were instructed to react only to the words. A key was placed on the screen below the word. The withdraw group had to press the key permanently and withdraw their finger on presentation of a word. Following withdrawal an increase in distance was simulated by reducing letter size. The touch group had to hold a finger on the key ready to press it when a word appeared. Following a key press a decrease in distance was simulated. Results showed that response times were faster to negative words in the withdraw condition and faster to positive words in the touch condition. So the affective congruency effect was observed even though the release of the button involved an arm flexion, and the button press involved an arm extension. The apparent movement could have been responsible for this effect, but as this response effect was not varied systematically tests for an influence were not possible.

My results are also consistent with research on reflexive responses that require no explicit evaluation, such as the early demonstration by Wickens (1938) who showed that reflexive responses can be quite flexible and contextually sensitive. Wickens (1938) had participants rest their hand palm downwards upon an electrode that transmitted an electric shock to the fingertip. Participants removed their fingers from the electrode as quickly as possible in response to the electric shock. To do this they extended their fingers. To test whether participants produced a specific motor action (extend to avoid) or a more general avoidance response (whatever action would allow them to avoid), Wickens turned the participant's hand over so that the electrode was still touching the palm but the palm was now facing upwards. In this case exhibiting the original extend response would actually drive the finger toward the electrode. Wickens showed that with this new positioning participants now flexed

their fingers to avoid the shock even though this was the opposite movement to the previous avoid response. He concluded that the response that was learned was defined by the spatial layout of the task, not by specific muscular movements made in the first part of the experiment.

My experiments specifically look at explicit evaluation and how situational factors can affect subsequent approach and avoidance tendencies. But future research could explore the impact of instructions and situated meaning in producing congruency effects within the automatic domain.

The influence of a response effect has also been demonstrated in non-emotional tasks such as the Simon effect, in which the consequences of a response become associated with the response (e.g. Grosjean and Mordkoff, 2002). Hommel (1993) showed that the Simon effect was determined by how people understood the effect of their responses. If they were instructed to press a key so as to make a light flash on the side contralateral to the key, then the Simon effect was based on the location of the light, not the key. Thus showing that it was the meaning of the response, the intended action goal, that mattered rather than the actual response itself.

So the importance of response effects has been demonstrated in non-emotional tasks and in reflexive responses requiring no explicit appraisal. I have directly tested the influence of spatial and non-spatial response effects in explicit affective judgment tasks, and have demonstrated the importance of situated meaning in the preparation of approach and avoid responses. My results demonstrating a flexible and effect-contingent set of approach and avoid behaviours do not rule out the possibility of a "default" set of responses, such as those suggested by Chen and Bargh (1999). The tendency to pull in attractive stimuli and hold aversive ones at arm's length might be

default options, but as my findings show, defaults that can be overridden based on the experience of how responses affect stimulus-observer relationships.

Interestingly I found similar results for a variety of different stimuli – pictures, words, and emotional faces. A congruency effect, and an influence of the response effect showing a reversal of the congruency effect due to situational factors, was found for all types of stimuli.

The congruency effects were bigger for the picture and word stimuli than for the faces. For the pictures and words participants were asked to respond based on their personal evaluation of the stimulus. For the faces the instructions were to always touch the emotional (happy or angry) faces or always touch the neutral faces. Whilst attention was therefore drawn to the valence of the faces, participants were not explicitly asked whether they liked or disliked the stimulus. This personal evaluation seems to increase the strength of the congruency effect. Automatic evaluation experiments (such as Chen and Bargh 1999; Duckworth et al, 2000) show very small congruency effects and it seems likely that the strength of the congruency effect is directly proportional to the amount of attention drawn to the valence and participants individual feelings towards the stimuli. This is another demonstration of how instructions and therefore situational factors can influence the congruency effect.

Finding congruency effects for pictures, words, and faces suggests that predispositions to approach and avoid occur for faces, which are processed quite rapidly, and for stimuli such as detailed pictures and words, which need a semantic retrieval based on previous experiences and associations. The similar results found regardless of stimulus modality suggest that the responses that are activated are unlikely to be based upon specific visual forms, but upon an amodal semantic evaluation of the stimulus.

I propose that upon encountering, and explicitly evaluating, a valenced object the behaviours needed to approach and avoid (to obtain desirable outcomes and avoid undesirable outcomes) are rapidly determined for that situation. These behaviours are then more easily and quickly executed due to the strong predisposition to approach pleasant objects and avoid unpleasant objects. So it is not necessarily a particular muscle movement that is primed upon explicit evaluation but whichever action will produce the desired outcome. So following explicit evaluation the predisposition to approach and avoid can work on a semantic basis (the participants understanding of what will be an approach or avoid response) rather than on a specific physical response. Given the complexity of the environment this is more beneficial than rigid flex and extend movements that would have to be overridden in certain circumstances. The ability to quickly ascertain and learn which movements will produce the desired effects allows us to survive in increasingly complex situations.

Many studies use flexing and extending positions to induce approach or avoid tendencies (Cacioppo et al 1993, Forster et al 1998, Neumann and Strack 2000 Experiment 1, Forster et al 2001, Forster 2003, Friedman and Forster 2005). The results of my experiments suggest that it is important to consider the strong influence of context in which behaviours will be understood as approach or avoid by the participants, and therefore which approach/avoid feelings and tendencies will be produced by performing particular flex and extend movements. My results suggest that in some circumstances extending can be an approach behaviour and flexing can be an avoid behaviour, and so it is vital not to assume that flexing will produce approach feelings and extending avoid feelings. This should be taken into account when designing and interpreting experiments in this domain.

Chapter 6.

Could an imbalanced approach/avoid system cause confabulation?

The previous chapters have investigated approach and avoid responses in healthy participants. These approach and avoid responses are important for normal functioning within one's environment. The preparation and execution of appropriate behaviours towards valenced stimuli keeps an individual safe, on a basic evolutionary level, and on a more sophisticated level allows an individual to function within the boundaries of our society. This chapter focuses on what happens when the approach/avoid response is impaired. Specifically, it concentrates on how deficits in the approach avoid response can be linked to the phenomenon of confabulation.

Confabulation is a form of false memory that occurs following a brain injury. The confabulating patient will often hold striking false beliefs, which they defend vigorously. The patient does not intend to deceive, instead the false belief reflects the patient's honest conception of the situation, and the patient will often become distressed if corrected. These false beliefs can range from denial of illness (for example paralysis or blindness) to confabulations about the patient's activities, which can be the mundane, for example a patient who believed he had an important business meeting to attend, or more fantastical, for example a patient who believed he had been a space pirate.

Confabulations occur following a number of different syndromes and injuries. These include: anosgonosia for hemiplegia, Anton's syndrome (a denial of blindness), split brain syndrome, alcoholic Korsakoff's syndrome, aneurysm of the anterior communicating artery (ACoA), Alzheimer's, and Capgras' syndrome (recognizing a loved one as an imposter) (Hirstein, 2005).

The confabulations of these syndromes differ markedly, but can be grouped into two categories: those in which the patient denies an illness, and those in which there is some degree of memory loss. First we look at those that involve denial of illness.

For anasognosia for hemiplegia, the patient denies the paralysis of the contra-lateral half of the body. When asked to demonstrate ability in the paralysed side the patient will give an excuse, perhaps that they are too tired to move, or will claim they have in fact moved when they have not. In some cases the patient will even deny that their paralysed arm belongs to them, claiming instead that it belongs to the doctor or a relative. Some patients even attempt to throw the "foreign" limb out of the bed, which can of course lead to the patient falling out of the bed too in an extremely confused state (Ramachandran and Blakeslee, 1998).

For Anton's syndrome, the patient denies that he or she is blind. When asked to report about what things look like, the patient will produce a detailed description, which is obviously completely erroneous. When questioned about the falsity of their description the patients will make excuses, for example that they do not have their glasses.

Split brain patients have had their corpus callosum removed to treat epilepsy. This effectively stops the epileptic seizures, but also prevents communication between the left and right brains. Because of this, the left hemisphere is unaware of the movements and intentions of the left side of the body, but when asked about the behaviour of the left arm, patients will often confabulate and respond with an erroneous reason as if the left hemisphere had been controlling it (Gazzaniga, 1995a).

Although the actual confabulations in these syndromes are quite different, they all involve a denial of a specific illness, or deficit, and the belief that they possess capabilities that they do not.

Alcoholic Korsakoff's syndrome, ACoA syndrome, and Alzheimers all involve some degree of memory loss. For Korsakoff's syndrome and ACoA syndrome the memory loss is severe, and the patient often cannot remember the events of the preceding day, but when asked the patient will produce an account of the events with complete confidence. These are often plausible and can relate to the patient's past, and to an outsider may be difficult to discern from the truth, such as attending an important meeting, but sometimes the claims are fanciful and are clearly made up, such as being a space pirate.

Alzheimer's is a progressive degenerative disorder in which the patient's memory for events, people, and eventually themselves and the world, declines unavoidably. At some stage in this degeneration, the patient, instead of admitting they do not know or cannot remember things, will produce confabulations, in a similar manner to patients with Korsakoffs, or ACoA syndrome.

So the syndromes discussed so far can be grouped into two categories; one in which the patient denies an illness, and one in which the patient denies a memory problem and creates positive fantasies. These denials result in the patient having a more positive view than the actual reality; that they are not paralysed, blind, unable to account for the behaviour of the left side of their body, or unable to remember. Capgras syndrome, in contrast, results in the patient having a more negative view of reality; that the patient's loved ones are in fact imposters, and has, in some cases, led to the patient killing the "imposter".

As there are many syndromes in which confabulation occurs, there are also many different types of brain injury that have led to these disorders and so may play a role in the confabulations. Researchers have searched for damage that is common amongst all of the disorders in their quest for a unified theory of the mechanisms of confabulation. This is a good place to start, although we may discover eventually that there are different types of confabulation caused by damage to different areas, and no single theory can encompass them all.

Anasognosia for hemiplegia usually occurs following a stroke and subsequent damage to the right inferior parietal cortex, which leaves the patient paralysed on the left hand side. Anton's syndrome appears to occur after bilateral damage to the occipital lobes coupled with frontal damage. While split brain patients have damage to the corpus callosum, which disrupts communication between the left and right hemispheres.

Korsakoff's syndrome appears to be most frequently caused by damage to the mamillary bodies and the dorsomedial nuclei of the thalamus. The anterior communicating artery feeds frontal structures, such as the orbitalfrontal cortex, and so a rupture will cause major damage to these areas. It is hypothesized that confabulations in Alzheimers arise when the frontal areas have undergone significant degeneration, and thus mirror the damage seen in Korsakoff's or ACoA syndrome. In Capgras Syndrome there is no known lesion site however possible suspects are temporal lesion coupled with a frontal lesion.

It is clear from these differing areas of damage that quite a task lies ahead in discerning which structures are important. Schnider (2001) claims that a common factor in producing confabulations appears to be damage, or disruption, to the

posterior medial orbito frontal cortex, OFC, which has connections with all cited structures. This has led to theories attributing confabulation to a frontal dysfunction.

Johnson's (1991) view is that confabulation occurs because of a disruption in reality monitoring. The patient's propensity to confabulate is caused by a deficit in motivation, judgment, retrieval, and encoding quality of memories. In this view a lack of motivation or judgment may lead to acceptance of false memories as true, as the checking process is no longer as stringent as it should be. On the other hand problems retrieving competing memories that would contradict the first recollection, may lead to the patient accepting the first thought or memory that enters consciousness. These reality monitoring problems occur in the presence of frontal lobe damage. One important question, then, is why don't all patients with frontal lobe damage confabulate?

Johnson, O'Connor and Cantor (1997) examined this question by comparing a confabulatory patient G.S to age matched patients with frontal lobe damage who do not confabulate, and to age matched neurologically normal controls, on tests of executive function. These included a temporal duration estimation task, temporal order discrimination task, identification of speaker task, memory characteristics of complex autobiographical events, and the minievents procedure (simulated autobiographical events).

Results showed that for the temporal duration task G.S. performed similarly to the frontal control patients and for the temporal order task his performance exceeded that of the frontal controls and resembled that of the normal controls. On the identification of speaker task there was no difference between his performance and that of the frontal control patients. Thus, deficits in temporal duration task and

speaker identification tasks, which measure source monitoring, cannot account for why he confabulates whilst other frontal patients do not.

G.S.'s performance did depart from that of frontal control patients on tests of qualitative aspects of his autobiographical memory. G.S. showed deficits in autobiographical memory when compared to the frontal controls. In addition, he showed an increased propensity to add details to imagined events, mirroring the level of detail found in the recollection of real events. This is very different to frontal patients, and normal controls, who generally produce less detail when describing imagined events than they do when describing real events.

Results therefore showed that relative to normal controls G.S. has a deficit in source monitoring (temporal duration and speaker identification), and relative to frontal controls he shows a deficit in the retrieval of autobiographical memories and a tendency to add excessive details to imagined events. Johnson et al (1997) conclude that it is unlikely that any one of these deficits alone would cause a confabulation but that a complex interplay of the factors is necessary in their production. Specifically, Johnson et al explain that a combination of these factors leads to difficulties discerning fact from fiction; poor autobiographical retrieval coupled with a problem identifying the source of any given memory, and the overly realistic qualities of imagined events, leads to the false confidence in untrue recollections, and the confabulation.

A related theory suggests that confabulations occur when there is a failure to suppress evoked memories that do not pertain to ongoing reality. This leads to continued activity of currently irrelevant memories (Schnider, 2001). Schnider provided support for this theory in an experiment where he presented two runs of a long series of pictures. In the first run participants have to view the pictures one by

one and indicate whether they have seen them before in that run. An hour later, in the second run the participants are presented with the same pictures in a different order. Participants are required to pretend that they have not seen the first run and only indicate a repeated picture if it is shown more than once in the second run. Thus the second run will contain some distracter items that have been seen before in the first run but are only presented once in the second run. Healthy participants have little trouble ignoring the distracters and therefore the irrelevant memories from the first run. However, confabulating patients perform poorly, finding it difficult to ignore the distracters and suppress the irrelevant memories.

Schinder (2001) linked these ideas about reality monitoring to reward. Correct performance on the second run of his task activated the posterior medial OFC of the healthy participants, the area that is commonly damaged in confabulating patients. This area has been shown to be important in the processing of reward in animal studies. Monkeys with damage to the posterior medial OFC continue to react to stimuli that are no longer rewarded. That is, these monkeys continue to base their actions on an irrelevant memory – that a particular behaviour was once associated with reward. This parallels the behaviour of confabulators who base their behaviour on currently irrelevant memories. Schnider goes on to say that meaningful behaviour can only occur when it is based on the current situation and when previous action plans that are no longer relevant are suppressed. He concludes that the posterior medial OFC inactivates evoked memories that do not relate to ongoing reality, and that this reality monitoring is a part of the brains reward system.

Recent investigations have supported the view that confabulations are linked to reward by highlighting the role of emotion in the phenomenon. Specifically Turnbull, Berry, and Evans (2004) have demonstrated that most patients show a

significant positive emotional bias in the content of their false beliefs (see also Fotopoulou, Solms, and Turnbull, 2004). This led to an investigation of whether the executive functions that are often impaired in confabulators particularly involve those functions that rely on an emotional or reward based element. To do this Turnbull, Worsey, and Evans (unpublished manuscript) examined the performance of a patient, EO, on tasks that measure emotion based learning such as the Iowa Gambling Task. They found that EO performed normally on the common version of the Iowa Gambling Task in which the valence associated with each deck is stable, but performed poorly on a set shifting version of this task and on the Bangor Gambling Task, in which the valence associated with the decks changes over time and thus requires flexible emotion based executive resources. Thus, confabulations seem to involve deficits in emotional functioning.

Johnson (1991; et al 1997) and Schinder's (2001) theories provide possible mechanisms for confabulations that occur when there is some degree of memory impairment and plausible fabrication regarding the patient's day-to-day activities, such as those seen in korsakoff's and ACoA syndrome. Can these mechanisms so readily explain confabulations occurring with anasognosia for hemiplegia or split brain syndrome, where the problem doesn't really relate to the patient's day-to-day activites, but more to their condition? Theories that are based on these syndromes have an important lateral component, basing their premise on the specialization of each hemisphere and communication between them.

One such theory first proposed by Geschwind (1965) and later modified by Joseph (1986) claims that confabulations are produced by the left hemisphere's language area when, for some reason, it does not receive the appropriate inputs. For example, in anasognosia it may not receive information about the left side of the

body, because the right inferior parietal cortex is damaged. The language area then tries to explain this lack of information, and this explanation is based either on random messages from the subcortex, or on the spontaneous firing of neurons in the language area. This theory explains confabulations in split brain patients too. In this disorder the input from the right hemisphere about the actions of the left side of the body cannot reach the language centres, because of the destroyed corpus callosum. The basis of this theory is that the language area is only as good as its input and has no "checking" processes of its own. The checking processes hypothesized to be in the frontal lobes are presumably impaired by the disconnection as well. This would make sense if they, too, are somehow lateralized.

A similar theory is proposed by Gazzaniga (1995a, 1995b, 2000). He attributes confabulation to an area in the left hemisphere that he calls "the interpreter". This interpreter, he claims, provides a commentary and a rational for our actions, thoughts, and beliefs, producing our sense of being a unified agent in control of our own actions. When this interpreter does not receive appropriate information because of damage to another brain area, or system, it concocts its own explanations, the confabulations. The main difference between Gazzaniga's and Joseph's (1991) theories just seems to be whilst one attributes the confabulations to a language axis the other attributes the confabulations to the interpreter, which presumably consists of a cognitive module that is in addition to the language areas. Generally speaking though the theories are quite similar, and suggest that confabulations are the product of a module in the left hemisphere, which continues to produce its output with no appropriate input. This is result of the balance of the specialization of the hemipshere's going awry, as the communication between them fails.

One major problem with the lateral theories is they do not fully account for why the frontal processes do not perform the appropriate checking processes and reject the false beliefs. As it stands there seems to be two camps, that of the frontal theories that explain the kind of confabulations following Korsakoff's, ACoA syndrome, and attribute this to a problem with the checking processes involved in autobiographical memory retrieval. The second camp is that of the lateral theories that seem to better explain anasognosia, and split brain syndrome confabulations, as a problem with communication between the two specialized hemispheres. In addition we have seen that there might be an important role for emotion in confabulation.

One explanation that might incorporate all these factors, and explain some confabulations, is a deficit in the approach/avoid system, which is hypothesized to be lateralized across the frontal lobes.

According to Davidson, Ekman, Saron, Senulis, and Friesen (1990) emotions and their linked approach/avoid tendencies are lateralized across the frontal lobes, with approach tendencies located in the left frontal lobe, and avoid tendencies located in the right frontal lobe. Evidence for this comes from the examination of brain activity that coincided with facial expressions of happiness and disgust. EEG recordings were taken from right-handed women at baseline and whilst viewing films. Participants viewed 2 films that evoked positive emotions and 2 films that evoked negative emotions.

EEG recordings, from left and right frontal, central, anterior temporal, and parietal regions, were taken when expressions of happiness and disgust occurred in the participants. Davidson et al (1990) predicted that the avoid emotion disgust would be associated with greater right-sided activation than happiness. Conversely he

expected the approach emotion happiness to be associated with greater left-sided activation than disgust.

Results showed that there was no difference in EEG asymmetry between the positive and negative film clips, but expressions of disgust were associated with more right-sided frontal and anterior temporal activation than the happy expressions. Expressions of happiness were associated with more left sided frontal and anterior temporal activation than the disgust expressions. No differences in activation asymmetry between happiness and disgust were found in the central or parietal regions. From this it was concluded that frontal and anterior right-sided regions are involved in disgust/withdrawal, and that frontal and anterior left-sided regions are involved in happiness/approach. It was confirmed that central and parietal regions are not involved. These results provide support for proposal that patterns of brain physiology are emotion specific rather than undifferentiated, and are consistent with approach-withdrawal lateralisation for affect. There are several shortcomings of this particular research such as the use of facial expressions to infer emotions, and the use of only two emotions, but the theory has gained some acceptance as more recent research has provided additional supporting evidence.

Schiff and Bassel (1999) used unilateral facial contractions to activate the contralateral hemisphere (rather than to activate an emotion) and then measured the reaction time taken to flex or extend a finger. The flexing, they argued, was associated with approaching as it mimicked a grasping motion, whereas the extending was associated with avoiding as it mimicked a releasing motion. They compared the reaction times following a facial contraction to the reaction times at baseline before any facial contraction was completed. They found that when participants used their right fingers they were quicker to flex (approach) and slower to extend (avoid) after

performing a right sided facial contraction, and thus activating the left sided approach system, than they were at baseline. When participants used their left fingers they were quicker to extend (avoid) after performing a left sided facial contraction, and thus activating the right-sided avoid system, than they were at baseline. Thus, the authors argue that their results show that right hemisphere activation facilitates withdrawal responses, and left hemisphere activation facilitates approach responses, and this is consistent with the hypothesis that approach and withdrawal tendencies are lateralized across the frontal lobes.

Whilst this does support the lateralization theory again there are some points to consider. Schiff and Bassel (1999) assign the finger flex movement to an approach movement, and the finger extension movement to an avoid movement. Their arguments that these reflect grasping and releasing are reasonable but one could argue that equally convincing arguments could be made for the flex being a withdrawal, as it retracts the finger away from the stimulus, and the extend being the approach, as it extends the finger towards the stimulus. If this were the case it could mean that the approach system is housed on the right and the withdrawal system on the left. So the results would still argue for lateralization but that the approach and withdrawal systems are lateralized in the opposing manner to the hypothesis. This is possible but the results from Davidson et al (1990) showing that the positive emotion happiness is lateralized on the left and the negative emotion disgust on the right are more consistent with Schiff and Bassel's proposal, though the question still remains as to why a flex is automatically associated with approaching and an extention is associated with withdrawal.

Recently Demaree, Everhart, Youngstrom, and Harrison (2005) reviewed the literature examining the lateralization of approach and withdrawal tendencies. They

argue that some of the most compelling evidence is provided by the Harmon-Jones laboratory who showed, over a number of studies, that anger is associated with increased activity in the left frontal lobe (Harmon-Jones and Allen, 1998; Harmon-Jones and Sigelman, 2001; Harmon-Jones, Sigelman, Bohlig, and Harmon-Jones, 2003). This argues for the left lateralization of approach tendencies regardless of affect and is strong support for the lateralization of approach and withdrawal as opposed to lateralization based on valence alone. Demaree et al also review an equally strong study by Sobotka, Davidson, and Senulis (1992) who asked participants to complete a task under conditions in which they could win money if they responded swiftly enough, or conditions in which they would lose money if they did not respond swiftly enough. They found that participants exhibited greater left-frontal arousal in "win" than "lose" conditions, thus showing a left lateralization for approach tendencies. After reviewing many studies Demeree et al argue that "the approach withdrawal model is compelling not only for its excellent fit to the available data but also for its theoretical importance (i.e. the motivational direction of an emotion is of utmost importance to species survival and procreation ability)". Thus there is strong support for the idea that approach and avoid tendencies are lateralized across the frontal lobes.

Using Davidson et al's (1990) lateralization theory I propose that normally the approach/avoid systems act as each other's counterpart, balancing behaviour and leading to stability in emotional functioning. This type of specialization and balance is seen elsewhere, such as the sympathetic and parasympathetic branches of the nervous system. This balance works as each system can monitor and inhibit the other. If one system is damaged, though, the consequences from the uninhibited system can be disastrous. In the case of the approach/avoid system what would happen to

emotion and the approach/avoid tendencies if one system were impaired? My hypothesis is that a damaged avoid system would leave an unchecked approach system leading to a positive emotional bias, risker behaviour, and pleasant fantasies, as seen in confabulations. Could a damaged avoid system then provide a possible account for some patients' confabulations? This chapter investigates this hypothesis in a patient who developed a confabulation following a traumatic head injury and subsequent right frontal lobectomy.

Case Study

EO

EO is a 45-year-old man, who sustained a severe head injury in an assault in October 2003. CT scan revealed an occipital skull fracture, on the left side, extending into the foramen magnum. There were bilateral orbitofrontal contusions, and a substantial contusion of the left temporal pole, that appeared to involve the amygdala. Three days after the assault it was necessary to perform a right frontal lobectomy, because of swelling and increased intracranial pressure.

Neurological Examination in November 2003 revealed intact visual fields and cranial nerves. There were no motor or sensory deficits and all reflexes were normal.

EO completed neuropsychological tests in December 2003. The Wechsler Abbreviated Scale of Intelligence showed that his full scale IQ was below average, as were both the performance IQ and verbal IQ components. EO showed impairments on aspects of memory that are less structured, such as recalling short stories and complex pictures, but had intact immediate and working memory, demonstrated by a normal digit span. Despite his extensive injuries his performance on tests of

executive function showed no impairments; set-shifting, planning and impulsivity were all normal. In 2004, EO completed tests that tap emotional based executive functioning as part of a research study; these showed that EO was impaired when flexible emotion based learning was required.

EO behaves in a socially appropriate manner and does not show any disinhibition, which might be expected following a frontal lobectomy. His account of his personal circumstances is accurate and unremarkable except for his one confabulatory belief. This is the belief that he is a trained helicopter pilot and that the Coast Guard helicopter had landed outside his house. Although EO had been a coast guard member and had flown in helicopters many times, he was not trained as a pilot, nor had he ever flown a helicopter. His wife reported that the confabulatory false belief had been frequently recurring theme throughout this illness, produced spontaneously by EO in the acute period. The frequency of these confabulations subsided in the two months following the assault, but when assessed EO would still spontaneously produce this confabulation "every day or two", and it could always be elicited by directly questioning him on the topic.

Approach and Avoid Task

EO will be compared to age matched neurologically normal controls on the approach/avoid task. The proposal is that EO's right frontal damage has impaired his avoid system. On this task then, the prediction is that EO will show deficits when avoiding both pleasant and unpleasant items. In addition it is possible that because his avoid system is damaged his approach system is no longer as inhibited as normal.

If this is the case EO might to have fast impulsive approach responses relative to controls.

Method

Participants. EO was compared to 6 neurologically normal controls (mean age = 57.7 years). In addition EO was compared to the twenty undergraduates (16 female, Mean age 20.05 years, SD = 1.28 years) from the Explicit Evaluation Experiment in Chapter 3.

Stimuli. Stimuli were identical to those used in the Explicit Evaluation Experiment (Chapter 3). Both the Picture and Word stimuli were used.

Design. The task in this experiment led to a within subjects design with factors of Side (Left/Right), Valence (Pleasant/Unpleasant), Behaviour (Approach/Avoid) and Order (Incongruent trials then Congruent trials/ Congruent trials then Incongruent trials).

Procedure. The procedure was identical to that used in the Explicit Evaluation Experiment with one exception. This time there was no delay or tone included in the task. The participants simply pressed the key on the keypad and released when they were ready to make a response. They were not required to wait for the 300ms and the tone before they responded. This is because I have found that patients often find this aspect of the task confusing and make errors that lead to many discarded trials. Given that the amount of trials a patient is often able to complete is limited I did not want to reduce the number of useable trials further. My experiment examining the time course of the congruency effect found on this task demonstrated that the effect occurs rapidly and dies down within a second; allowing the patient and controls to respond immediately in this experiment therefore should not reduce or influence the effects seen.

Participants completed the word trials first starting with the congruent condition and following with the incongruent condition. They then had a short break of a few minutes and completed the picture trials with the incongruent condition first and the congruent condition second. This does create a confound in the sense that we cannot separate Stimulus Type (Picture/Word) from Order and any effects seen from these conditions could be due to either factor creating an influence. This should not create a problem because all previous experiments have shown no difference between congruency effects for Words and Pictures and that the effect of Order is strong and consistent across experiments. These factors do not bear on our main hypothesis and will not be used to draw any conclusions. It is not ideal to have such a confound, but when testing the responses of individuals to compare to single patients it is difficult, if not impossible, to counterbalance every factor. The important thing to note is that all participants completed exactly the same task with the same conditions in the same order, and so any differences seen can be attributed to differences between the individuals and are not created by the task.

Following the main experimental tasks participants completed a rating task. In this task the picture and word stimuli appeared one by one in the centre of the screen and participants had to rate how unpleasant or pleasant they found each stimulus on a scale from 1-7 (1 being very unpleasant and 7 being very pleasant). They did this using allocated keys on the keypad.

Results

Prior to analysis, RT distributions were iteratively trimmed to include scores within 3 standard deviations of the mean, for each condition and for each participant. Only correct trials, those in which participants' approach/avoid behaviour under the task conditions matched their post experimental rating, were included in the analysis.

A repeated measures analysis of variance (ANOVA) was conducted on the data from the neurologically normal controls with Side (Left/Right), Valence (Pleasant/Unpleasant), Behaviour (Approach/Avoid) and Order (Incongruent trials then Congruent trials/ Congruent trials then Incongruent trials) as within subjects factors. The interaction of Valence by Behaviour gives us the important factor of Congruency used in previous experiments, and allows a more detailed examination of the Congruent and Incongruent responses. Specifically, using this interaction allows a comparison of patient and control performance on the four different conditions: approaching and avoiding pleasant items and approaching and avoiding unpleasant items. This provides an advantage as it may reveal a deficit in one of the conditions that might be masked if only Congruent versus Incongruent responses were considered.

The analysis on the neurologically normal control data revealed a significant interaction of Valence by Behaviour $F(1,5) = 52.99$, $p = .001$. Participants were faster to approach pleasant and avoid unpleasant items, than to approach unpleasant and avoid pleasant items. This is the congruency effect demonstrated in previous experiments. See Figure 6.1, page 150.

The interaction of Valence by Behaviour by Side was almost significant $F(1,5) = 5.59$, $p = .064$, showing that the congruency effect is much smaller for the unpleasant items on the right, and slightly larger for pleasant items on the right. This

appears to be caused by a speeded approach response to items on the right. In terms of Davidson et al's (1990) laterality theory one could argue that the left hemisphere is specialized for approaching, which leads to amplified approach responses to items on the right. Using this theory we would expect similar amplification of avoid responses on the left, which does not appear to be the case. The other possibility is that participants are simply faster to approach items on the right than on the left because they are right-handed. Again we would expect similar speeding of responses when avoiding an item on the left, which involves a right-sided touch. One reason why this may not occur so strongly is that the participant might have trouble disengaging attention from the valenced left-sided item after orienting towards it to explicitly judge the valence, and this disengagement problem may mask the speeding of responses on the right.

This is supported by the significant main effect of Side $F(1,5) = 7.33$, $p < .05$, which reflected faster responses to items presented on the Right than on the Left, and a significant interaction of Side by Behaviour $F(1,5) = 8.43$, $p < .05$, showing that participants were faster to approach than to avoid items on the right and had similar response times to approach and avoid items on the left. These effects both suggest that right-handed participants find it easier to make a response on the right. When the valenced item is on the right we see a large speeding effect. This speeding seems to be dampened when the valenced item is on the left, and demands an avoid response on the right, which might be due to the time taken to disengage attention from the valenced item. This, of course, does not rule out the laterality effects that Davidson et al would predict. They may be at work too, but no strong conclusions can be made about them given the confound created by right-handed participants.

There were also some significant effects involving Order that do not particularly bear on our hypotheses. Firstly there was an interaction of Valence by Behaviour by Order, $F(1,5) = 24.43$, $p = .004$, which simply shows that participants are faster on the second block.

There was also an interaction of Order by Valence $F(1,5) = 8.46$, $p = .033$. This showed that responses to pleasant trials were faster than responses to unpleasant trials when participants completed the incongruent block first (pictures), and that responses to unpleasant trials were faster than responses to pleasant trials when participants completed the congruent block first (words).

Before we look at the results of EO it is important to review how the results from the age-matched controls compare to those of undergraduates. This comparison reveals that both sets of controls have a similar pattern of results. See Figure 6.1 overleaf.

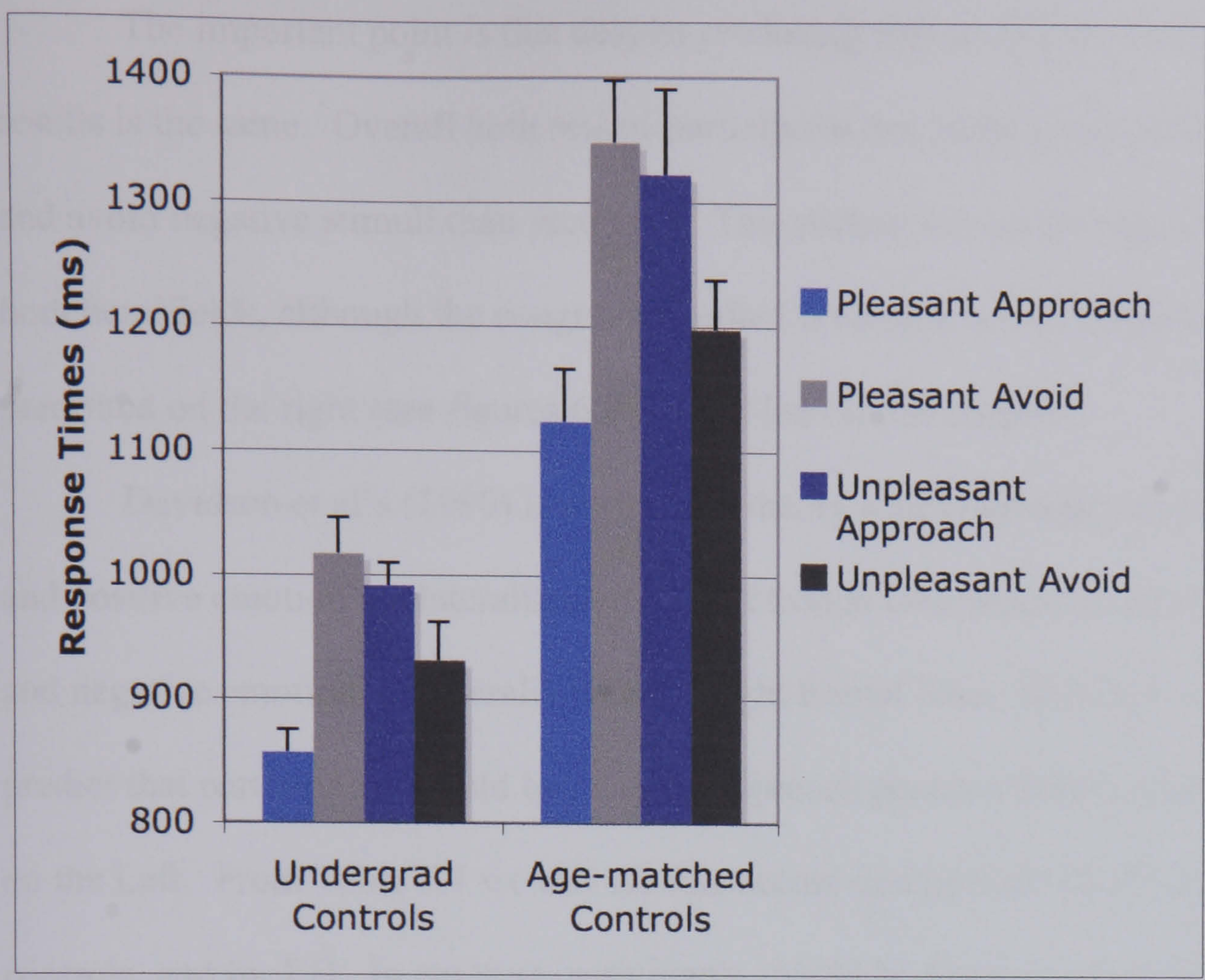

Figure 6.1. A comparison of the Mean Response Times for the Undergraduate Controls and the Age-Matched Controls.

The most striking difference is the speed of the responses. Undergraduates respond much faster (M = 949ms) on average than the age matched controls (M = 1248ms), $t(24) = -3.995$, $p = .001$. This is might be a combination of slower reactions as we age and that the older participants may be less impulsive. Alternatively, the slower responses from the older participants could be caused by the fact that in the task they completed there was no requirement to wait for 300ms before responding. This meant that the undergrads had 300ms in which to start to prepare their response but the older participants did not. This may have caused the undergrads to respond more quickly than the older participants.

The important point is that despite producing slower responses the pattern of results is the same. Overall both sets of participants are faster to approach positive and avoid negative stimuli than vice versa. This pattern occurs for stimuli presented to both hemifields, although the congruency effect is smaller for the unpleasant items presented on the right (see figures 6.3 and 6.4 later in the chapter).

Davidson et al's (1990) lateralization theory states that approach tendencies and positive emotion are lateralized in the left frontal lobe whereas avoid tendencies and negative emotion are lateralized in the right frontal lobe. This theory would predict that participants should be faster to approach pleasant things on the Right than on the Left. From Table 6.1 we can see this occurs descriptively for both sets of controls, and for EO. In contrast participants should be faster to avoid unpleasant items presented on the Left than on the Right. Again we see this occurs descriptively for both sets of controls, but importantly not for EO. This interaction is not significant for the undergrads, $F(1,18) = 0.203$, $p = .658$, or for the age matched controls $F(1,5) = 1.327$, $p = .302$.

Table 6.1. *Mean Response Times (in milliseconds) to Approach Pleasant and Avoid Unpleasant items presented on the Left and on the Right.*

	Undergraduate Controls		Age-matched Controls		Patient EO	
	Left	Right	Left	Right	Left	Right
Approach Pleasant	861	853	1150	1098	1158	1064
Avoid Unpleasant	926	935	1195	1201	1422	1339

Given that an ANOVA is not statistically appropriate for examining the results from a single patient, EO's data was analysed using Crawford and Garthwaite's (2005) Revised Standardized Difference Test, which controls for small group size and reduces the possibility of Type 1 error. In the RSDT EO's means for each condition are compared to the age-matched control's means and standard deviations, and examined for a discrepancy from the norm. The relevant interaction for our hypothesis is that of Valence by Behaviour. Therefore, the RSDT was used to compare patient and control responses for approaching and avoiding pleasant items, and approaching and avoiding unpleasant items.

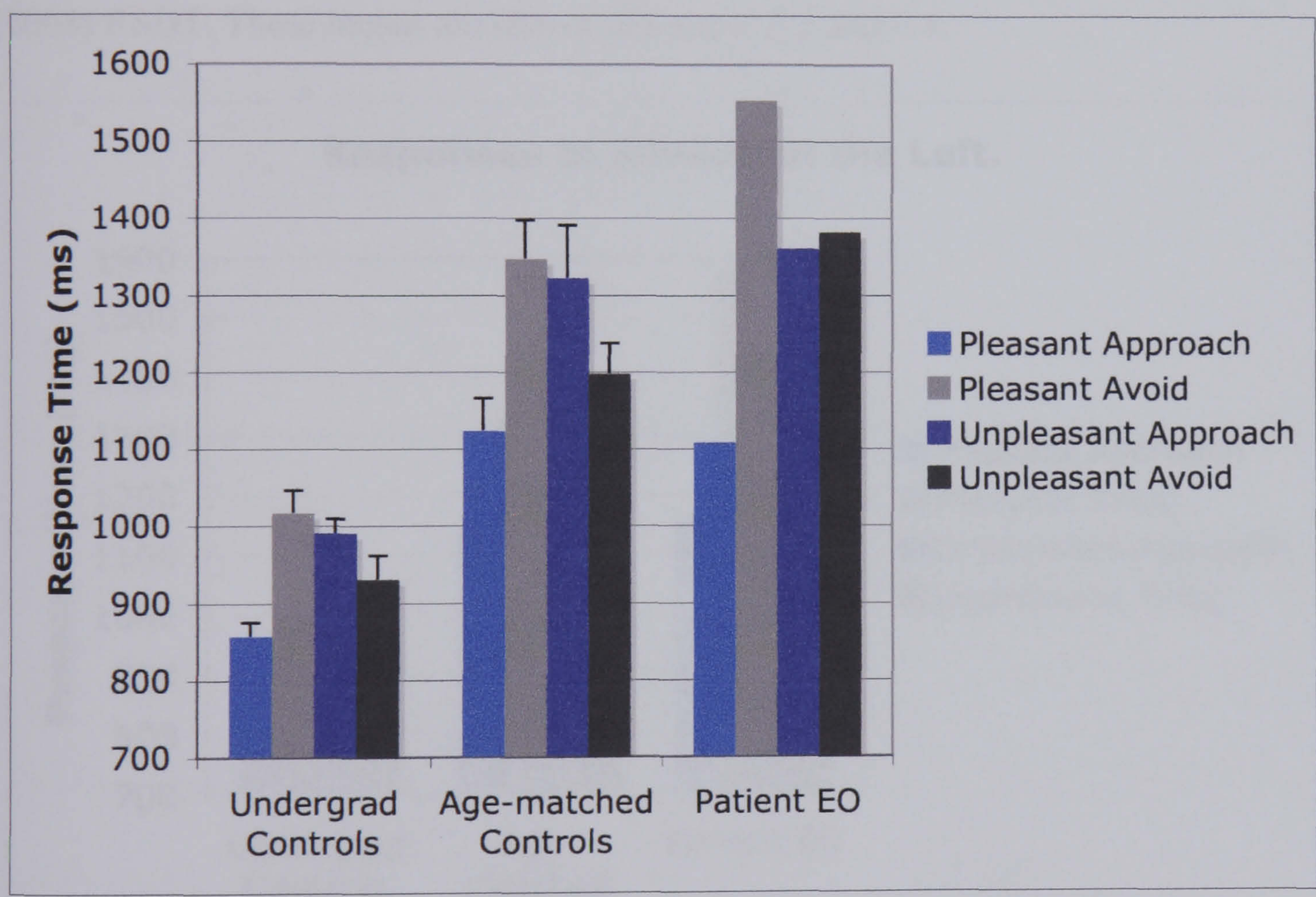

Figure 6.2. A comparison of the Mean Response Times made by both sets of Controls and Patient EO.

The RSDT showed that for the unpleasant items EO's performance was almost significantly different from controls, $t(5) = 2.174$, $p = .082$. For the pleasant items EO's performance was not significantly different from controls, $t(5) = 1.491$, $p =$

.196. Figure. 6.2 shows that for unpleasant items EO shows no congruency effect. This is due to a slow avoid response to these items. Descriptively EO also has a very slow response when avoiding pleasant items. This leads to an exaggerated congruency effect for pleasant items. The results suggest, then, that EO has a diminished avoid response to both pleasant and unpleasant items.

EO's responses were then examined in more detail to see how his performance approaching and avoiding the valenced items compared on the left and right sides. This is the Valence by Behaviour by Side interaction. EO's means for each condition were compared to controls' means for each condition on Crawford and Garthwaite's (2005) RSDT. These means are shown in Figures 6.3 and 6.4.

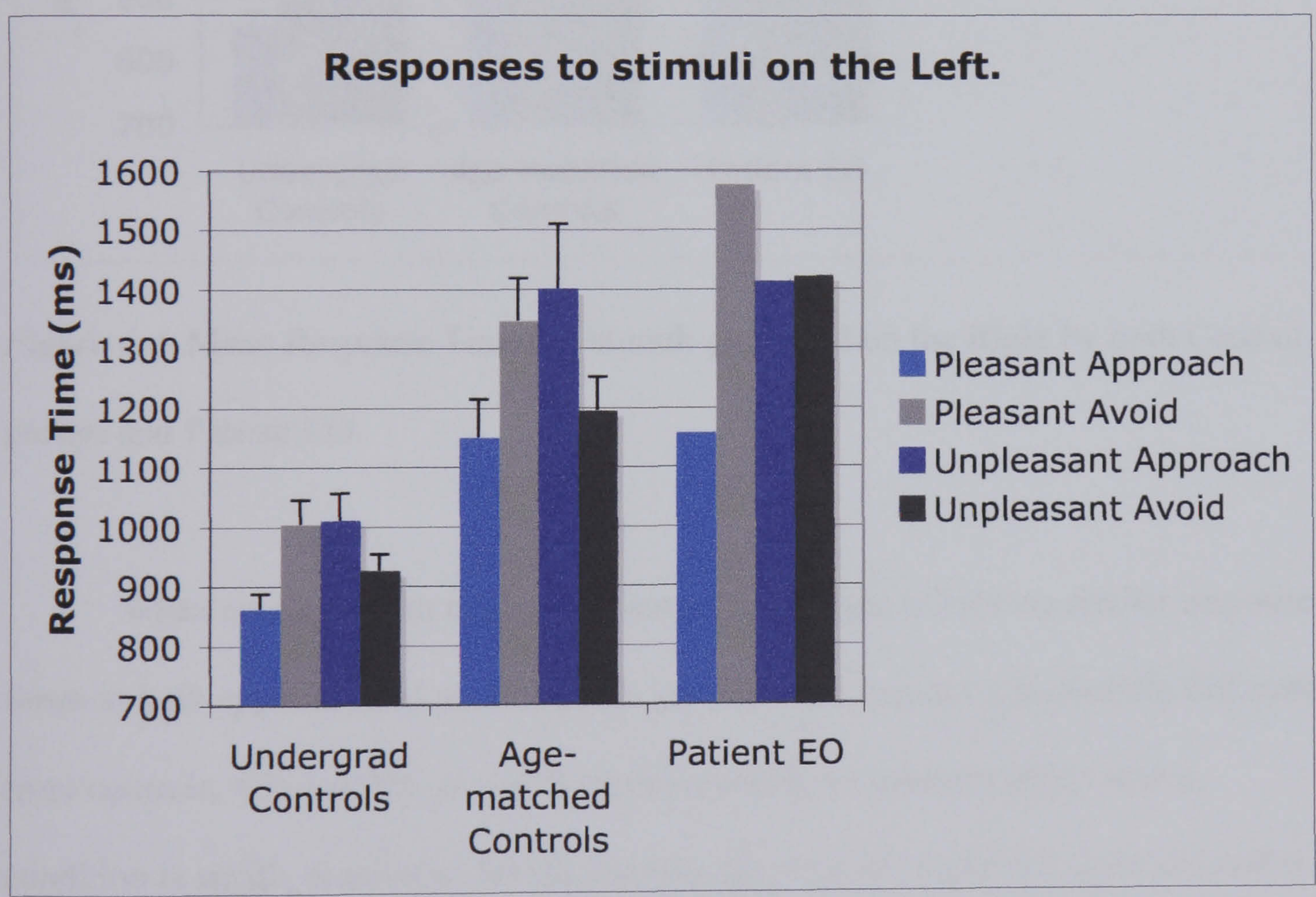

Figure 6.3. Mean Response Times to stimuli presented on the Left by both Control groups and Patient EO.

The results showed that EO differed significantly from controls when responding to unpleasant items on the left, $t(5) = 3.521$, $p = .0017$. His approach

response was similar to controls, but his avoid response was slowed. For the pleasant items on the left EO showed an exaggerated congruency effect due to a slow avoid response, but this was not significantly different from controls, t(5) = 1.276, p = .258.

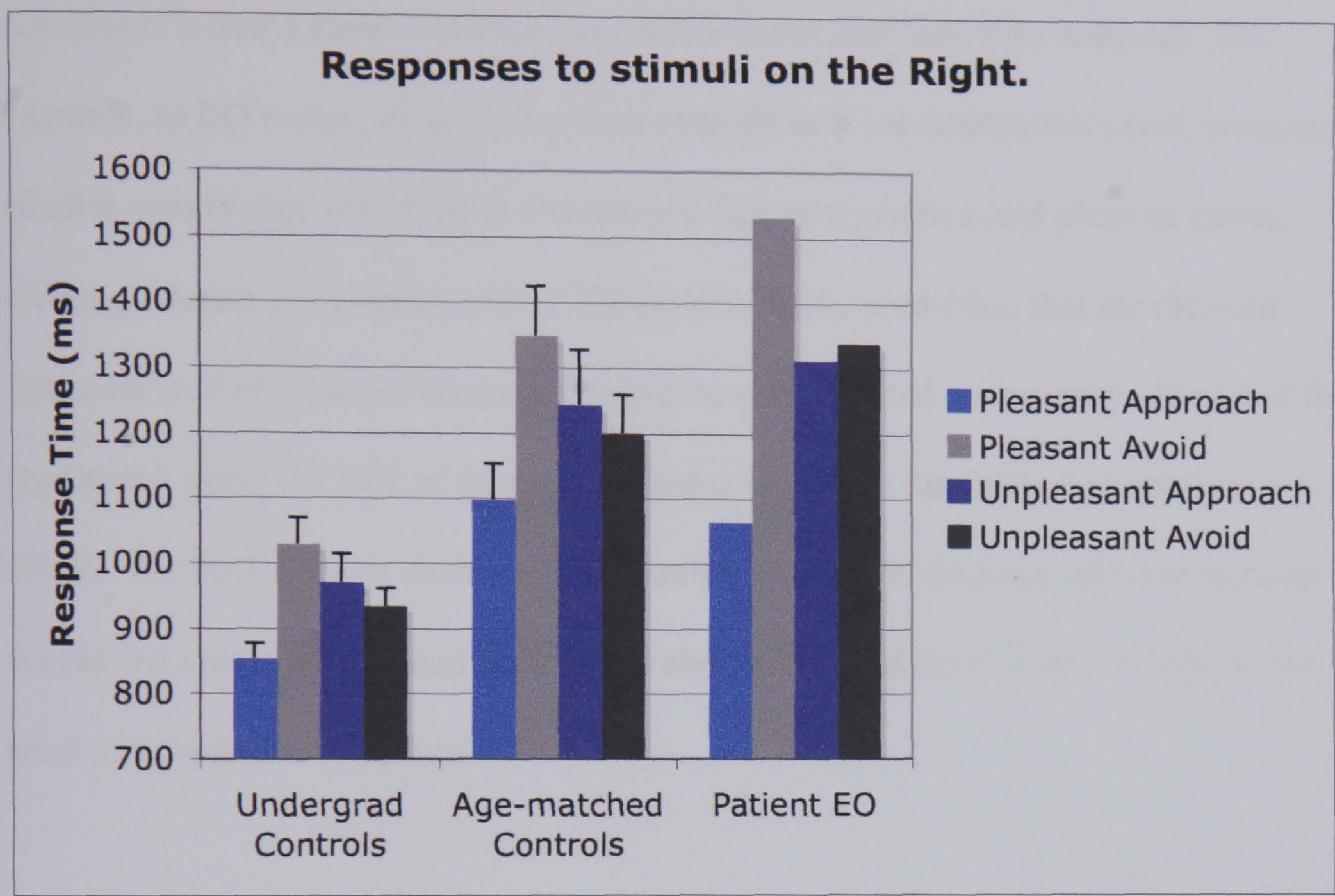

Figure 6.4. Mean Response Times to stimuli presented on the Right by both Control groups and Patient EO.

When responding to unpleasant items on the right EO shows similar response times to both approach and avoid, but his performance was not significantly different from controls, t(5) = 0.766, p = .479, as the controls congruency effect in this condition is small. Similarly, for the pleasant items on the right EO again showed an exaggerated congruency effect due to a slow avoid response, and again this difference was not significant, t(5) = 1.313, p = .246.

This more detailed analysis shows that the biggest difference between EO and controls is occurring for the unpleasant items in his contra-lesional field. EO no

longer shows a speeded avoid response to these items and is just as slow to avoid as to approach them.

One major limitation of the RSDT is that in comparing means for particular conditions it treats these conditions as more independent than they truly are. For example, in EO's case, he is slower than controls to avoid unpleasant items, creating a smaller congruency effect; he is also slower than controls to avoid pleasant items, creating a larger congruency effect. This confirms my prediction that for pleasant items the lack of an avoid response leads to an exaggerated congruency effect, but for unpleasant items the lack of an avoid response leads to a diminished congruency effect. The RSDT treats each case separately though, and does not take into account the related nature of the conditions. This should be considered when examining the level of significance obtained.

Discussion

Confabulation occurs after many different types of brain injury, and although there are many different proposals, so far no unified theory exists to explain the phenomenon. The results from my experiment are consistent with a new theory about why some confabulations may occur. I showed that on my approach/avoid task the performance of a confabulatory patient, EO, was markedly different from the performance of age matched neurologically normal controls. Specifically, controls' performance shows the expected congruency effect; they are faster to respond when approaching pleasant items than when avoiding pleasant items, and faster to respond when avoiding unpleasant items than when approaching unpleasant items. EO, however, has a very slow response when avoiding items, which leads to diminished

congruency effects for unpleasant items and exaggerated congruency effects for pleasant items.

I can explain this performance using Davidson et al's (1990) laterality theory. Davidson et al suggested that positive emotions and approach tendencies are lateralized in the left hemisphere, and that negative emotions and avoid tendencies are lateralized in the right hemisphere. These normally act as each other's counterbalance, keeping each other in check. If the right hemisphere were damaged though, as in EO's case, this might lead to a damaged avoid system and an unchecked approach system. EO's performance on my task fits in with this hypothesis; he does not display normal avoid responses to unpleasant or pleasant items. When EO is instructed to avoid the unpleasant items, he no longer shows a normal speeded avoid response. Response times are similar when approaching and avoiding unpleasant items, as the avoid system does not appear to be working as expected. When EO is instructed to avoid the pleasant items his response is also slowed (though not significantly so) suggesting a difficulty avoiding these desirable items and inhibiting the approach response.

How does this deficit relate to his confabulations? I suggest that the approach system creates a positive fantasy. In EO's case though he no longer has a fully functioning avoid system to balance out the positive approach tendencies, and to provide a reality check. Not only does EO have the positive belief that he is a helicopter pilot, he has also admitted that given the opportunity he would attempt to fly one; in fact this was how he was planning to return home from the hospital. So the confabulation is not just confined to a positive belief but extends into his behaviour. He would readily approach the deadly situation of helicopter flight with no pilot's experience, and it seems he would experience no inhibiting avoid tendencies.

So I attribute EO's confabulations to a damaged avoid system that is located in the right frontal lobe. Like other theories, the idea is twofold. First the approach system in the left frontal lobe creates a positive fantasy, then the appropriate inhibiting properties of the avoid system do not work. As Hirstein (2005) writes "One of the characters involved in an inner dialogue has fallen silent as the other rambles on unchecked".

What is interesting is that whilst the damaged right frontal lobe does seem to have diminished EO's avoid system, it does not appear to make him quick to approach all items as one might imagine an unchecked approach system would do. Clearly damage to the avoid system does not hamper the approach response as measured by my task. I can still suggest that the damaged avoid system, and unchecked approach system, are possible causes for his confabulation. EO's confabulation is highly specific, and he behaves appropriately in all other aspects of his life. Perhaps instead of approaching any item regardless, an unchecked approach system focuses on a specific and highly desirable goal or fantasy. This theory then fits in with the specific nature of many confabulations (Burgess and McNeil, 1999) and that the patient often behaves in a socially acceptable manner aside from the specific area of the confabulation.

Thus the results from EO fit the theory, but it should be noted that no strong conclusions can be made based on one case study. Individual case studies are valuable when they are considered along side others, as each piece can help build up a complete picture. Thus whilst studying single patients is important work, the theory I present needs to be supported by future case studies before it can be accepted. Running my experiment with additional frontal patients with confabulatory beliefs is planned for the near future. In addition my patient based work would be improved by

testing more older controls as the small number of controls, and patients, in this experiment leads to a lack of power which may mask the effects. So, research with additional patients and more controls may provide further support for my theory.

Could this theory account for all types of confabulation? Certainly it could explain confabulations following frontal damage, such as those in Korsakoff's, ACoA, Alzheimers, and Anton's. It also fits in with the findings that most confabulations are positive (Turnbull, Berry and Evans, 2004) and occur following right-sided damage (Hirstein, 2005). The damaged avoid system on the right would decrease negative emotions and avoid behaviour, leading to more positive views than normal and an inability to verify them.

The approach/avoid theory might not so readily account for anasognosia for hemiplegia, split brain syndrome, and Capgras. Anasognosia for hemiplegia seems to involve damage to the right inferior parietal cortex, and not to the frontal areas associated with approaching and avoiding. I could suggest that this damage disrupts connections between the frontal areas and that this leads to a diminished avoid input to the left hemisphere. This could also be suggested as a possible mechanism in Split Brain syndrome. Schnider (2001) does state that the areas damaged in these conditions have important connections to frontal areas such as the OFC. Capgras does have a frontal element but differs from the other disorders in that the confabulations are quite negative. If a brain injury involved the left frontal lobe, perhaps the inhibiting properties of the approach system would be equally diminished, and the patient may have a more negative view of the world and exaggerated avoid tendencies. This might explain Capgras but the theory would rely on the damage causing Capgras syndrome being lateralized or at least more severe on the left.

It has been suggested that a mirror image syndrome of confabulation is Obsessive Compulsive Disorder (Hirstein, 2005), a disorder in which the patient is excessively paranoid and doubts his own actions. Perhaps this disorder can be explained as a damaged approach system and an overactive avoid system. This would link positive emotions and approach tendencies to confidence, and negative emotions and avoid tendencies to paranoia. When the avoid system goes awry we are left with positive false beliefs that the patient has absolute confidence in. When the approach system goes awry we are left with negative false beliefs and paranoia about them. Therefore, it would be intriguing to see how an OCD patient performed on my approach/avoid task.

As it stands there is no theory that explains all types of confabulations. It does seem possible that there might be different types of confabulations explained by different theories. My theory, and my results that are consistent with it, do not prove other theories incorrect, but instead add a new perspective from which to approach the etiology of confabulation.

My approach/avoid task can provide an important tool in testing different types of confabulations, and related disorders such as OCD. Many psychological disorders might be understood as the result of a disrupted or imbalanced approach/avoid system. The balance between approach and avoid systems is likely to be critical for effective and socially acceptable behaviour. For example, agoraphobia (where people perhaps have overdeveloped avoid strategies) and impulsive hedonistic behaviour (where people perhaps have overdeveloped approach strategies), which can lead to criminal activity or participation risky behaviours. Understanding the neuropsychological mechanisms underlying approach and avoid behaviours could

therefore offer crucial, as yet unexplored, insights for a range of psychological disorders.

Chapter 7.

Amygdala damage and the approach/avoid response.

The amygdala is an almond-shaped nucleus that is part of the limbic system, and is located in the anterior temporal lobe. Numerous studies have provided evidence that the amygdala plays a role in the recognition of threat related stimuli, and it is now widely accepted that the amygdala is important for our normal orientation towards, and recognition of, visual stimuli of negative emotional significance. In addition to this, the amygdala is important in producing expressions of emotion. That is, as well as recognition, the amygdala is involved in the response to the stimuli. It is possible that the amygdala might also be involved in the predisposition to approach or avoid a stimulus. If the amygdala were damaged would the predisposition to approach and avoid be impaired? This chapter focuses on this question by examining how a patient with amygdala damage performs on our approach/avoid task.

First, though, the evidence for the amygdala's role in the recognition of threat will be reviewed. This evidence comes from different strands of research; neuroimaging studies of amygdala activity in neurologically normal participants when they are processing emotional information, and studies of patients with amygdala damage.

Firstly Ledoux (2000) has shown that the amygdala has widespread connections to many brain regions. These include sensory inputs from all modalities, and projections to regions capable of moderating behaviour, (Amaral, Behniea, and Kelly, 2003; Holland and Gallagher, 1999). These direct projections reach all cortical stages along the ventral visual stream, Amaral et al (2003), showing that it is ideally placed to process fear and threat.

Neuroimaging studies have shown that the amygdala's level of activation changes when participants view facial expressions of emotions such as fear and happiness. This occurs for explicitly and implicitly viewed stimuli.

Morris et al (1998) used positron emission tomography (PET) to scan brain activity whilst participants completed a gender discrimination task on images of faces that were expressing various intensities of fear and happiness. This showed enhanced amygdala activity when viewing the fearful faces, demonstrating the amygdala's role in the processing of consciously perceived threat related stimuli (see also Phillips et al, 1998)

To demonstrate the amygdala's role in implicit processing, Whalen, Rauch, Etcoff, McInerney, Lee, Jenike (1998) backwardly masked facial expressions of fear and happiness. Participants do not consciously perceive the emotional facial expressions that are presented for 33ms, and only notice the neutral faces that are presented immediately afterwards. Despite the implicit nature of the processing of the emotional expressions, functional magnetic resonance imaging (fMRI) shows amygdala activation is significantly higher when exposed to the fearful faces than to the happy faces, and this is due to a significant increase in activation for the fearful faces, and a significant decrease in activation for the happy faces.

The two pathway hypothesis suggests that there is a cortical pathway to the amygdala depending on conscious processing of the stimuli, and a subcortical pathway, through the pulvinar nucleus of the thalamus and the superior colliculus (SC), for the processing of implict consciously-undetected threatening stimuli. Evidence for this comes from fMRI studies that have demonstrated enhanced amygdala, pulvinar, and SC activation to masked, and therefore implicitly detected, stimuli in neurologically normal controls (Morris, Ohman, and Dolan,1999).

Patients with blindsight also provide very strong support for this hypothesis. Blindsight patients have a damaged striate cortex making them blind in the contralateral field, but can still discriminate emotional expressions in this blind hemifield, suggesting a subcortical visual pathway. Morris, Degelder, Weiskrantz, and Dolan (2001) used fMRI to reveal that the amygdala, pulvinar and SC showed enhanced activation when a blindsight patient was presented with fearful, and fear conditioned, faces in his blind hemifield. These results provide strong support for a subcortical pathway that can process threat related stimuli rapidly, and independently, from conscious awareness.

Results from our own lab have implicated the pulvinar in this subcortical pathway. Ward, Danziger and Bamford (2005) showed that the detection of threat related stimuli was impaired in a patient, SM, with unilateral left-sided damage to the pulvinar. We used a dot probe task in which a pleasant or threatening image was presented laterally for 300 or 600ms, and then was followed by a coloured circle presented in the same location. The task was to determine the colour of the circle and to make a speeded response. Controls showed a slowed response to circles following the threatening images relative to those following the pleasant images, and this occurred in both hemifields. In addition, interference reduced over time, so that responses were faster for the 600ms condition than for the 300ms condition and there was a trend for this reduction in interference to affect responses following threatening images more so than those following pleasant images.

In contrast to controls, SM shows a difference between his hemifields. In his ipsilesional field he behaves similarly to controls; responses are slowed following threatening images relative to pleasant images. But in his contralesional field a different pattern emerges. At the 300ms delay responses to the circle do not show the

usual slowing after threatening images, and so responses are actually faster following the threatening images than following the pleasant images. The pattern switches over at the 600ms delay and, like controls, SMs responses are slowed to the threatening images. This shows that pulvinar damage affects subsequent responses; the initial interference caused by threatening images seen in controls is absent in SM but then emerges over time. This suggests that the fast subcortical threat detection route through the pulvinar is interrupted by the pulvinar damage and that the later interference from the threatening images may be caused by cortical input from the amygdala.

In line with this, further fMRI studies have shown that the amygdala shows greater activation to low spatial frequency faces than to high spatial frequency faces (Vuilleumier, Armony, Driver, and Dolan, 2003) demonstrating that the amygdala is especially sensitive to coarse visual information (such as wide fearful eyes). And Vuilleumier, (2005) suggested that the amygdala might feedback early information and affect visual processing in other areas additively. So the amygdala is capable of rapidly detecting coarse threat related information through the subcortical pathway, and might then feedback this information to enhance conscious visual processing and attention to the stimuli.

Neuroimaging studies then have demonstrated that the amygdala shows enhanced activity to stimuli associated with emotion, fear, and threat, and that this occurs for both explicitly and implicitly processed items. Further studies have provided evidence that there are dissociable routes to the amygdala, a subcortical route for rapid detection of coarse threat related information, and a slower cortical route that processes more detailed aspects into conscious awareness.

Lesion studies have been based on patients with bilateral or unilateral amygdala damage and have compared the patient's performance to neurologically normal controls. This line of research has shown that patients with amygdala damage often have deficits recognizing facial expressions of negative emotions, most often fear, but sometimes anger, sadness, and surprise (Calder et al, 1996; Calder, Lawrence, and Young, 2001; Schmolck and Squire, 2001; Adolphs, Baron-Cohen, and Tranel, 2002; Broks et al, 1998)

Adolphs, Tranel, Damasio, and Damasio (1994) examined the performance of patient SM who had bilateral amygdala damage. SM completed a rating task in which she was presented with an emotional expression and an emotional label that was either congruent or incongruent with the expression. She had to rate the intensity to which the face expressed the emotional label. SM rated expressions of fear, anger and surprise as less intense than any of the brain damaged, or normal, controls to which she was compared. In addition, further analyses showed that SM's ratings of fearful faces showed less correlation with ratings from normal controls than the brain damaged patients correlation with normal controls. Thus showing she had an impairment in recognising fear.

Some studies however have presented cases of patients with amygdala damage who do not appear to have deficits recognising negative emotional stimuli. Using exactly the same task as Adolphs et al (1994), Hanmann et al (1996) failed to find any significant impairments in recognising any emotion in two patients with complete bilateral damage to the amygdala.

These discrepancies have been examined by Schmolck and Squire (2001). They noted that in many studies in which amygdala damage was shown to impair fear recognition, (Calder et al, 1996; Broks et al, 1998), a different task had been

employed. In this task participants were presented with an emotional expression and had to choose one of six emotional labels to describe it. Following this discovery, Schmolck and Squire used the same group of patients as Hamann et al (1996) and assessed their ability to both rate and label emotions.

On the labelling tasks patients performed more poorly than controls when presented with emotional expressions of fear and sadness. This effect was significant. On the rating task the data were analysed by correlating patients ratings with control ratings, as Hamann et al (1996) did. The results confirmed Hamann et al's conclusion. Patients were behaving similarly to controls. But Schmolck and Squire (2001) carried out further analyses using the mean ratings for each trial. They found that patients gave higher ratings than controls and these higher ratings were specific to certain face-adjective pairings. These pairs correlated highly with the incorrect trials on the labelling task suggesting that patients had difficulty discriminating between certain emotions. In particular they confused fear with surprise and anger, and sadness with disgust and anger. These findings could not be detected using Hamann et al's correlation alone.

So by examining patients' behaviour it is apparent that two different impairments can arise after amygdala damage. The amygdala patients in Hamann et al's (1996) study were impaired on the ability to discriminate between negative emotions, as shown in the labelling task and by the high ratings to certain pairs in the rating task. Patient SM, studied by Adolphs et al (1994), was impaired on the recognition of negative facial emotions shown by low ratings in the rating task. These two variations may account for non-significant results using certain tasks and analyses.

The amygdala has also been linked to the approach/avoid continuum. Anderson, Fulbright, Spencer, and Phelps (2000) compared patients with unilateral left (LTL) or right (RTL) amygdala damage to controls on the evaluation of facial expressions. These patients had undergone unilateral medial temporal lobectomy to control epileptic seizures, which resulted in removal of amygdala, hippocampus, parahippocampus and certain projection fibers. This resulted in highly similar lesions in the RTL and LTL patients. The participants were presented with facial expressions of fear, anger, disgust, happiness, sadness, and surprise, and asked to rate how well an emotional adjective matched the facial expression. For example, the facial expression of happiness would be paired with the question "How Happy does this person look?" and participants were required to respond using a scale from 1, not at all, to 6, very much. The task was blocked by emotional adjective so that an emotional adjective was shown with each facial expression, and then the next emotional adjective was shown with each facial expression, and so on. Thus, each emotional adjective was paired with each emotional expression.

The rating scores from the matching emotional expressions and adjectives (e.g. ratings of happy facial expressions when asked about happiness) were examined and results showed that patients with right amygdala damage rated the expressions as significantly less intense than the left amygdala damage patients and controls. Further analyses showed that this was specific to emotion. Right amygdala damage patients were impaired in their ratings of sad, fearful, disgusted, and happy faces. Anderson et al (2000) suggested that this showed that the right amygdala patients were most severely compromised on emotions of withdrawal or avoidance.

They concluded that their study showed that left amygdala damage did not result in an impairment in evaluating facial expressions of emotion, but that right

amygdala damage did result in such an impairment, and was most pronounced for those emotions that are associated with withdrawal. They claim that this shows that the affective asymmetries proposed for cortical functions, extend to structures such as the amygdala and the adjacent anteromedial cortex. Their findings that recognition of anger was not impaired in the RTL patients does support this, as anger is categorized as an aggressive approach related behaviour. One major weakness in their argument of course are the RTL patients' impairments in recognizing happiness, which is also seen as an approach related behaviour. Anderson et al (2000) discuss this and suggest that the additional damage to the adjacent substantia innominata, which is responsive to expressions of happiness and fear, could be responsible for the impairments in the recognition of happiness. They also clarify that their findings are consistent with a "differential" but not "selective" impairment in the withdrawal related emotions.

A question that could be raised from these results is why the LTL patients did not show differential impairments in approach related emotions such as happiness or anger. This is not discussed and it is unclear whether the authors suggest that the left amygdala would be specialized for approach related emotions as the right amygdala is for withdrawal related emotions.

In addition to studies showing deficits in recognizing facial expressions, patients with amygdala damage have also been shown to respond abnormally on an attentional blink task. The attentional blink effect occurs when participants are required to identify targets in rapid succession. After identification of a target there is a temporary window in which a subsequent target will not be detected, as the attentional resources required are indisposed. This attentional blink is reduced if the second target is of emotional significance; that is emotional stimuli presented during

the attentional blink are often recognized when non-emotional stimuli would go unnoticed.

Anderson and Phelps (2001) used an attentional blink paradigm and compared the responses of a patient S.P. with bilateral amygdala damage, ten patients with unilateral left or right amygdala damage, and twenty neurologically normal controls. They presented trials of fifteen words, comprising two targets and thirteen distracters. In the affective salience condition the first target (T1) was a neutral word (such as house, or broom), and the second (T2) an aversive word (such as rape, or bastard), which was more negative and arousing than the neutral target. In the control condition both targets were neutral words. In both conditions the distracters were neutral words that were longer than the targets to ensure sufficient masking. Distracters were presented in black, and targets in green. The fifteen words were rapidly presented sequentially and participants were required to report the targets by typing them at the end of the trial.

Results showed that controls identified negative T2 targets with greater accuracy than neutral T2 targets, consistent with the attenuation of the attentional blink phenomenon for emotionally significant items. In contrast, the bilateral amygdala patient, S.P., showed no advantage for negative compared to neutral words, although she showed a normal attentional blink effect.

When the performance of the unilateral amygdala damage patients was examined, results showed that the RTL patients did not differ from controls in their performance. They showed the same increased accuracy for negative T2 targets than for neutral T2 targets. In contrast the LTL patients showed no significant advantage for the detection of negative versus neutral T2 targets. Further examination of the results showed that when the participants were asked to rate the words for valence and

arousal both controls and patients rated the negative words as more negative and more arousing than then neutral words, showing that the impaired influence of emotionally significant items on the attentional blink was not due to a deficit in categorizing the valence of the stimuli.

Anderson and Phelps (2001) conclude from their study that the amygdala is important for enhancing the perception of emotionally significant items. In their study the left amygdala appeared to be exerting the crucial influence, but this could be stimulus specific, as words were used as the targets and distracters. If non-verbal stimuli had been used then damage to the right amygdala might have similarly impaired the modulation of the attentional blink. Anderson and Phelps consider this idea in their discussion, and entertain its liklihood saying that the hemispheric asymmetries for verbal and non-verbal events might extend beyond cortical function to subcortical structures such as the amygdala.

These two studies further demonstrate the complexity of the results from patients with unilateral amygdala damage. In Anderson et al (2000) they show an impairment in recognising negative emotions related to withdrawal in RTL patients, and no deficit in LTL patients. In Anderson and Phelps (2001) they show an impairment in the enhanced awareness for negative words in LTL patients but not in RTL patients. Task specific effects might be a possible explanation for this; one could argue the left amygdala's specialization for verbal stimuli and the right amygdala's specialization for non-verbal stimuli such as facial expressions, is a factor in producing this pattern of results. But no firm conclusions can be drawn from this.

Adding further complexity to the laterality issue are a series of studies by Cahill, Uncapher, Kilpatrick, Alkire, Turner, (2004). Cahill et al exposed gender differences in the functions of the left and right amygdala. He measured the brain

activity of neurologically normal participants using PET whilst they viewed a number of graphically violent films. A few weeks later the participants had to recall what they had seen. The number of films remembered correlated with the level of activity in their amygdalae during viewing. Cahill et al then noticed that in some studies the activation was only in the left amygdala and some studies only in the right amygdala, and that this correlated with the gender of the participants. Specifically, the studies showing right activation involved male participants and the studies showing left activation involved only female participants. Clearly the processes in which one remembers emotionally significant events differ between men and women.

Cahill et al (2004) then proposed that hemispheric differences might extend to the amygdala. Specifically, he suggested that the specialization for fine detail seen in the left hemisphere may be present in the left amygdala, and similarly the specialization for processing more general aspects of an event might be present in the right amygdala. Thus if male and female brains rely on opposing amygdalae in the formation of memory of emotional events there may be differences in how and what they remember.

Cahill et al (2004) tested this theory by administering a beta blocker, that would suppress the activity in the amygdala, to participants who viewed an emotionally arousing film. He predicted that this would suppress the right amygdala in men and so diminish the ability to recall the general aspects or gist of the film. In women it would suppress the left amygdala and diminish the ability to remember the details of the film. This is exactly what he found, memory of emotional events involves higher activation of the right amygdala in men, making them more likely to remember the gist of an emotional event, and involved higher activation in the left amygdala in women making them more likely to remember the details of an

emotional event. So the same emotional event will be processed differently in male and female brains.

Whilst this relates more to the formation of emotional memories than it does the recognition of emotional expressions or stimuli, it still suggests that there may be gender factors to consider where the amygdala's, and indeed any brain structure's, function is investigated. Gender difference might be a contributing factor in the complexity of the impairments seen following unilateral amygdala damage.

As well as gender, age seems to be a factor in how the amygdala responds to emotional events. Based on the idea that older adults experience less negative emotions, Mather et al (2004) examined whether amygdala activation to positive and negative emotional pictures changes with age. They used FMRI to measure amygdala activity whilst participants viewed positive, negative, and neutral pictures, and rated them for arousal. They found that amygdala activation was greater for emotional than for neutral pictures for both young (mean age 23.41) and older (mean age 78.41) adults. They differed however in their responses to positive and negative pictures; older adults showed greater activation to positive pictures than to negative pictures whilst younger adults did not. This difference was due to the older adults having a diminished amygdala response to negative pictures, and they determined that this was because older adults diminish their encoding of negative emotional experience in the first few moments of the event. The differences in how younger and older adults' amygdala's respond to emotional stimuli are important when comparing studies with contrasting results, and reiterates the importance of age matched controls for patient research.

Lesion studies, neuroimaging studies, and the amygdala's positioning and biological connections, provide strong evidence of the amygdala's role in the

recognition of threatening stimuli. This chapter investigates whether the amygdala's role extends to the approach/avoid response, by looking at the performance of a patient with unilateral amygdala damage on my approach/avoid task.

Case study

SH

SH is a 50 year-old woman who sustained a serious head injury as the result of a horse riding accident in 1976, at the age of 19. The accident resulted in traumatic contusions of the left temporal pole, including the amygdala and the orbito frontal cortex on the left. Neurological Examination in 2001 revealed no focal neurological deficit, except for a right superior quadrant visual field defect, presumably related to the temporal lobe contusion, which damaged Meyer's Loop of the optic radiations.

SH completed neuropsychological tests in 2003. The Wechsler Abbreviated Scale of Intelligence showed that her full scale IQ was in the low-average region. Full scale IQ comprises performance IQ, which was in the average region, and verbal IQ, which was in the low-average region. The lower scores on the verbal IQ scale are consistent with her left-sided damage. Her visual and verbal memory scores were below average, although they remained in the normal range. The Rivermead Behavioural Memory Test, which measures memory skills related to everyday situations, also revealed some impairments. Her biggest impairments were in the realm of executive control; she showed impairments in set shifting, planning, problem solving and inhibition of responses. Since the accident SH has had greater problems with emotional control, and she also suffers from seizures suspected to be temporal lobe epilepsy.

Approach and Avoid Task

SH will be compared to age matched neurologically normal controls on the approach/avoid task. If the amygdala is involved, not only in the detection of threatening stimuli, but also in the preparation of an appropriate response, then the congruency effect demonstrated by control participants will not be present in the patient's contra-lesional field. If a normal approach/avoid response is seen in both fields then this will suggest that the amygdala is not necessary for the predisposition to approach and avoid emotional stimuli.

Method

Stimuli. Stimuli in the Approach/Avoid task were identical to those used in the previous experiments. Both pictures and words were used.

Design. The Approach/Avoid task in this experiment led to a within subjects design with factors of Side (Left/Right), Valence (Pleasant/Unpleasant), Behaviour (Approach/Avoid) and Order (Incongruent trials then Congruent trials/ Congruent trials then Incongruent trials).

Procedure. The approach/avoid procedure was identical to that used in the previous chapter with EO.

Results

Prior to analysis, RT distributions were iteratively trimmed to include scores within 3 standard deviations of the mean, for each condition and for each participant. Only correct trials, those in which participants' approach/avoid behaviour under the task conditions matched their post experimental rating, were included in the analysis.

SH was compared to the same set of controls as EO, therefore the results from the neurologically normal controls are identical to those reported in the previous chapter. The important results will be briefly reviewed here.

A repeated measures analysis of variance (ANOVA) was conducted on the data from the neurologically normal controls with Side (Left/Right), Valence (Pleasant/Unpleasant), Behaviour (Approach/Avoid) and Order (Incongruent trials then Congruent trials/ Congruent trials then Incongruent trials) as within subjects factors.

The analysis on the neurologically normal control data revealed a significant interaction of Valence by Behaviour $F(1,5) = 52.99$, $p = .001$. Participants were faster to approach pleasant and avoid unpleasant items, than to approach unpleasant and avoid pleasant items. This is the congruency effect demonstrated in previous experiments.

The interaction of Valence by Behaviour by Side was almost significant $F(1,5) = 5.59$, $p = .064$, showing that the congruency effect is much smaller for the unpleasant items on the right, and slightly larger for pleasant items on the right.

There was a significant main effect of Side $F(1,5) = 7.33$, $p < .05$, which reflected faster responses to items presented on the Right than on the Left, and a significant interaction of Side by Behaviour $F(1,5) = 8.43$, $p < .05$, showing that participants were faster to approach than to avoid items on the right and had similar response times to approach and avoid items on the left. These effects both suggest that right-handed participants find it easier to make a response on the right.

SH's data was analysed using Crawford and Garthwaite's (2005) Revised Standardized Difference Test, which controls for small group size and reduces the possibility of Type 1 error. In the RSDT SH's means for each condition are

compared to the controls' means and standard deviations, and examined for a discrepancy from the norm.

The difference between SH's Approach and Avoid response times were compared to those of controls in four conditions; Pleasant items on the Left, and on the Right, and Unpleasant items on the Left, and on the Right. For Pleasant items SH's Approach and Avoid responses were not significantly different from controls on either the Left $t(5) = 0.002$, $p = .998$, or Right $t(5) = 0.196$, $p = .852$. SH showed the same pattern of results as controls; faster responses to approach pleasant then to avoid pleasant items. For the Unpleasant items SH was not significantly different from controls for items presented on the Left $t(5) = 1.579$, $p = .18$, or on the Right, $t(5) = 0.125$, $p = .905$, showing faster responses to avoid unpleasant than to approach.

But the analysis revealed that for the Unpleasant items on the Right she was significantly slower than controls to both Approach $t(5) = 2.270$, $p = .036$, and to Avoid $t(5) = 2.326$, $p = .034$; this shows slower response times to Unpleasant items on the Right, rather than a smaller or larger congruency effect. This would suggest that her approach and avoid tendencies are still intact but her ability to classify the unpleasant items in her contra-lesional field has been impaired. See Figures 7.1 and 7.2.

Figure 7.1. Showing that SH has a normal predisposition to respond to valenced stimuli. She is faster to approach pleasant and avoid unpleasant stimuli than to approach unpleasant and avoid pleasant stimuli in both hemifields.

Figure 7.2 showing that SH has significantly slower responses than controls to unpleasant items in her contra-lesional (right) hemifield.

Discussion

Numerous studies have demonstrated that the amygdala is important for the recognition of fear and threat, and some have suggested that this structure is particularly important for emotions that are linked to behavioural withdrawal. I tested a patient with amygdala damage on my approach /avoid task to investigate whether the amygdala is also important for the approach/avoid response.

SH's performance on my task shows that her approach/avoid responses are not impaired. She shows the same predisposition to approach pleasant items and avoid unpleasant items as neurologically normal controls. That is, controls are faster to approach pleasant and avoid unpleasant items than they are to approach unpleasant

and avoid pleasant items. This congruency effect is maintained for SH's responses. However, detailed examination of her responses shows that SH has slowed responses to unpleasant items in her contra-lesional field, which is consistent with a problem in recognizing these items as unpleasant. I only used the correctly classified items in our analysis, and so the results show that although she was slower to classify them, which suggests a difficulty in recognition of their valence relative to controls, she did manage to correctly categorize them given time, and then the appropriate predisposition to approach or avoid occurred leading to her displaying a normal congruency effect.

Interestingly, examination of SH's incorrect trials shows that instead of being random mistakes as controls make, incorrectly responding to random pleasant and unpleasant stimuli when making speeded responses in the task, SH makes mistakes with a small number of stimuli consistently. Specifically she rates a small number of items as unpleasant in the centrally presented valence rating task that followed the main experimental task, but classifies them as pleasant on a number of occasions when they are presented laterally within the main experimental task. These mistakes occur an equal number of times for items presented in both fields. These items were: dentist, hatred, knives, spinach, and food. The first four are rated as unpleasant in Fazio's norming study, so it is likely that the classification mistake is made in the approach/avoid task. The inconsistencies in the ratings for the word *food* are less clear however. In Fazio's norming study *food* is rated as pleasant. There can be wide differences in individual ratings for different stimuli, which is why I included individual post experimental rating tasks, and with society's fascination with weight, diet, and health, people often have unpredictable attitudes towards food, which may be the case with SH. This is pure speculation however, and I cannot say for certain

where the classification mistake has occurred. Because it is unclear whether these mistakes have been made during the approach/avoid task, or in the rating task afterwards, I have not included these trials in the main analysis, but their occurrence is consistent with the idea that SH does have a problem classifying stimuli when they are presented laterally and a speeded judgment is required.

This pattern of results relates to Anderson and Phelps (2001) attentional blink study reviewed earlier. Anderson and Phelps find that the enhanced perception of the unpleasant words is impaired in the attentional blink task, i.e. noticing the stimuli are unpleasant when they are presented rapidly, but that the recognition of these items as unpleasant is not impaired in the valence rating task. Similarly, we find that judging the valence of unpleasant items under time constraints is impaired, but not in a centrally presented no-time-limit rating task.

My results from the approach/avoid task show that SH's left amygdala and OFC damage does not seem to have impaired her approach avoid predisposition. But consistent with previous studies from many domains, I have shown that damage to the left amygdala and OFC has resulted in an impairment in the recognition of unpleasant items in her contra-lesional field. The lack of power from a single case and a small number of controls does mean that deficits could be missed, so we cannot conclude from this one case that amygdala damage is not involved in the approach/avoid predisposition. Instead it means that my results are consistent with this conclusion and that further patient studies are needed to confirm it.

Anderson et al (2000) suggested that the right amygdala was specialized for emotions associated with withdrawal. It was unclear whether their hypothesis extended to the left amygdala being associated with approach related emotions. In our study it seems that the left amygdala is involved in the recognition of unpleasant

items, which would be more associated with withdrawal than approach. And our results suggest that the left amygdala is not necessary for approach or withdrawal predispositions. Of course, age and gender issues, as well as imperfect lesion sites, make general conclusions from a single case unsound, but these results provide a first step in understanding the structures involved in the approach/avoid response.

My approach/avoid task, then, provides a new paradigm for testing the impairments of amygdala patients, and indeed many other types of patients, and allows us to look in fine detail at where the deficits lie. For example, SH shows an impairment in recognizing the unpleasant items in her contra-lesional field, demonstrated by slowed response times but an intact congruency effect. EO, on the other hand, shows an intact recognition of pleasant and unpleasant items, but an impairment in his avoid response, demonstrated by especially slow avoid responses, that led to exaggerated congruency effects for pleasant items, and diminished congruency effects for unpleasant items.

From this I have demonstrated that the OFC damage SH sustained has not caused a deficit in the approach/avoid response in this particular case. SH has left OFC damage and does not show approach or avoid deficits. EO has more extensive frontal damage and does show an avoid deficit. This tentatively points towards another or an additional frontal area that is able to drive the predisposition to appropriate approach avoid behaviour. Of course it is possible that the OFC is responsible for approach/avoid behaviour and that SH's damage is just not extensive enough to create a problem. This case can obviously not stand alone in pinpointing the necessary brain areas, but when added to future research may help to elucidate which structures are important.

One major improvement in this research would be the creation of an automatic evaluation approach/avoid task that produces large and reliable effects in controls. This would then rule out the problems associated with discrepancies in classifications made during the task and those made when rating the valence of the stimuli afterwards. It would also concentrate the focus of the task onto deficits in approaching and avoiding and completely bypass problems in the classification of stimuli. Because of this an automatic evaluation task would make an ideal partner, rather than a replacement for, the explicit evaluation task I have designed. The explicit task is good as it can address and reveal problems in the classification of valenced stimuli, but an automatic task would be better for some patients who do have a major problem with explicitly classifying the stimuli. Also it would consist of a simpler task. With no explicit judgment to base responses on, the task would be easier for some patients to complete correctly. It would also allow us to see if automatic and explicit processing are both impaired in the same way. Unfortunately, despite several attempts, I have been unable to create such a task.

Another improvement would be the inclusion of additional patients with right sided or bilateral damage, and further testing on other patients with left sided damage. Results from a single case study need to be replicated and confirmed in other patients before strong conclusions can be made. Difficulties in finding and recruiting patients, and the rarity of isolated amygdala damage, makes lesion based research imperfect, but opportunities to study these patients should be readily seized as taken together these studies can paint a detailed picture of the functions of brain structures.

In conclusion, in this chapter I extended the research on amygdala function and investigated whether impairments following amygdala damage are confined to recognition of emotional stimuli or whether they extend to the predisposition to

approach or avoid these stimuli. In a patient with unilateral left sided damage to the amygdala and OFC, I showed that the approach and avoid predispositions were intact in both ipsi and contra-lesional fields, but that consistent with previous research she had a deficit in recognizing unpleasant items in her contra-lesional field. This confirms that the amygdala is important in the recognition of unpleasant stimuli, but suggests that the left amygdala and OFC might not be necessary for the approach/avoid response.

Chapter 8

General Discussion

At the beginning of the thesis I reviewed the research that demonstrated that stimuli could be unintentionally, and in that sense automatically, evaluated. It was proposed that rapid evaluation of stimuli confers an advantage because it produces a predisposition to respond appropriately, by approaching pleasant or rewarding items and avoiding unpleasant or threatening items (Chen and Bargh, 1999). A few researchers have demonstrated a link between both automatic, and explicit, evaluation and approaching and avoiding (Solarz, 1960; Chen and Bargh, 1999; De Houwer et al 2001; Duckworth et al 2002; Castelli et al, 2004). This has been done using centrally presented stimuli with healthy neurologically normal participants. The purpose of the thesis was to create an approach/avoid paradigm with lateralized presentation of stimuli that would be suitable for patient testing. This would allow me to extend the previous approach/avoid research that examined responses in healthy participants to patients with different types of brain damage. During the design and implementation of this patient suitable paradigm I encountered difficulties in producing congruency effects following automatic evaluation; this led me to investigate aspects of the evaluation and approach/avoid response in healthy participants in addition to my patient based work.

This discussion will conclude the thesis by providing a summary of each experimental chapter, an assessment of my approach/avoid task as a neuropsychological research tool, and a proposed model for the approach/avoid predisposition.

A Summary of each Experimental Chapter.

Chapter 3. Explicit evaluation and the approach/avoid response.

The experiments in Chapter 3 introduced my approach/avoid paradigm. I presented an explicit evaluation approach/avoid task with lateralized valenced stimuli presentation, specifically designed to make it suitable for testing patients with unilateral damage. The first experiment showed that my explicit evaluation approach/avoid task produced large and reliable congruency effects in neurologically normal undergraduate participants.

I then examined the time course of this congruency effect. In the second experiment I varied the Stimulus Onset Asynchrony (SOA) between presentation of the valenced stimuli, and a go signal indicating that the participants could respond. I showed that the congruency effect was at its largest when the SOA was 300ms. It had decreased slightly by 650ms, and had diminished further by 1000ms. This showed that the predisposition to approach and avoid valenced stimuli occurred rapidly, and then was overridden when participants were given time to respond.

Chapter 4. Automatic evaluation and the approach/avoid response.

In Chapter 4 I presented five experiments that attempted to find a large reliable congruency effect using an automatic version of my approach/avoid task. In the automatic version, participants responded to an imperative target and the valenced stimuli were irrelevant. In the first three automatic approach/avoid experiments I did not manage to produce any congruency effects despite manipulating SOA, and the stimuli. The fourth and fifth experiments were specifically designed to examine why a congruency effect in an automatic task was so hard to produce, given the large effects

seen on explicit versions. The lack of an effect is especially puzzling given the evolutionary theories suggesting that the predisposition to approach/avoid is an adaptive back up system, that can orient and respond to emotionally relevant stimuli rapidly and efficiently, whilst conscious attention is elsewhere. These experiments specifically looked at whether rating the stimuli before the main experimental task could lead to a congruency effect in this task. I found that neither rating the specific stimuli used in the approach/avoid task, nor rating different stimuli, and hence having attention drawn to valence in a more general way, produced a congruency effect. Thus, from these experiments it seems that explicitly evaluating the stimuli in an online concurrent manner is necessary to produce a large congruency effect comparable to that demonstrated in our explicit task.

Chapter 5. Predispositions to approach and avoid are not just valence specific motor responses but actions that produce the desired environmental effect.

In Chapter 5 I examined the claim that evaluating a visual stimulus as positive or negative evokes a specific motor response, extending the arm to negative stimuli, and contracting to positive stimuli. Instead, I demonstrated that predispositions to approach and avoid do not consist simply of specific motor patterns but are more abstract functions that produce a desired environmental effect. I showed that a large congruency effect (participants were faster to approach pleasant and avoid unpleasant stimuli, than approach unpleasant and avoid pleasant stimuli) could be reversed by spatial, and non-spatial, response effects that changed participants' understanding of the situation.

Chapters 6 and 7 applied the approach/avoid line of research to patients with specific forms of brain damage, to elucidate the brain structures involved in producing the approach/avoid behaviours.

Chapter 6. Could an imbalanced approach/avoid system cause confabulation?

In Chapter 6 I examined the performance of a confabulatory patient on my explicit evaluation approach/avoid task (developed in Chapter 3). This patient, EO, underwent a right frontal lobectomy, and since has had the confabulatory belief that he is a helicopter pilot. Based on the suggestion that valence and associated approach and avoid emotions are lateralized across the frontal lobes (Davidson et al, 1990), I proposed that EO's confabulations could be caused by a damaged imbalanced approach/avoid system. Specifically, Davidson et al (1990) proposed that the approach system is lateralized in the left frontal lobe, and that the avoid system is lateralized in the right frontal lobe. I proposed, then, that EO's damaged right frontal lobe leads to an impaired avoid system. This impairment can leave the approach system unchecked and result in positive false beliefs, such as being a helicopter pilot.

EO's performance on the approach/avoid task supported this theory; he showed diminished avoid responses to both pleasant and unpleasant items. This led to exaggerated congruency effects for pleasant items; he was still very quick to approach these items, but especially slow to inhibit the approach response and avoid them. For the unpleasant items he showed no congruency effect; he was still very slow to approach these items but also slow to avoid them.

These results supported my hypothesis that an impairment in the approach/avoid system could be a cause of, or a contributing factor to, confabulations. They also provide further evidence for Davidson et al's (1990) lateralization theory.

This experiment then provided a new perspective from which to examine and understand confabulations, and an example of the applicability of the approach/avoid task to patient based research.

Chapter 7. Amygdala damage and the approach/avoid response.

In Chapter 7 I examined the performance of a patient, SH, with unilateral left amygdala damage, on the explicit evaluation approach/avoid task. Research has shown that amygdala damage impairs the recognition of emotionally significant, and especially threat related, stimuli. I wished to test whether this impairment is restricted to the recognition of valenced stimuli, or if the impairment extends to the approach/avoid predisposition. That is, is the amygdala important for the approach/avoid response?

SH's performance showed that her approach/avoid predisposition was intact. She was faster to approach pleasant and avoid unpleasant items, than to approach unpleasant and avoid pleasant items, in both ipsi and contra-lateral fields. However, her responses in general were slower than those of controls, and significantly so for unpleasant items in her contra-lateral field. This suggests an impairment in classifying the valence of unpleasant items. These results agree with previous research showing that the amygdala plays a role in the recognition of emotionally relevant stimuli, and suggests that the left amygdala is not necessary for the approach/avoid predisposition. This is an important extension to the previous research on amygdala function, which has largely focused on its role in the recognition of emotional stimuli, and emotional memory. This experiment also highlights how the approach/avoid task I have created can reveal different types of

impairments, those in the classification of valenced stimuli, such as SH, and those in the approach/avoid response, such as EO.

The approach avoid task as a research tool in neuropsychology.

My explicit evaluation approach/avoid paradigm allowed me to investigate the brain structures involved in explicit evaluation and the predisposition to approach and avoid. Using the task I provided further evidence for the lateralization of the approach/avoid system in the frontal lobes, and linked the disorder of confabulation to an impairment in this system. I also provided evidence for the role of the amygdala in evaluation. This links two previously unconnected strands of research: patient based lesion studies and the link between evaluation and the approach avoid response.

Given that a main objective of the thesis was to create an approach/avoid task suitable for patient testing it is important to assess my explicit evaluation approach/avoid paradigm on its applicability for patient based work.

Strengths

The design of my explicit evaluation paradigm, that can measure approach/avoid tendencies in patients with unilateral damage, is a major contribution to current research. Previous research into this topic has focused on the behaviour of healthy participants using centrally presented stimuli (Chen and Bargh 1999; De Houwer et al 2001; Duckworth et al 2002). My research has produced a task using laterally presented stimuli on touch-screen software. The equipment is portable which provides the opportunity to take the experiment to patients who may not be well enough to travel, and who otherwise would not able to participate. Given the

rarity of specific forms of isolated brain damage essential for this type of investigation my paradigm is therefore a major advancement to an existing area of research. My task has the additional and equally important characteristic of yielding large effects in healthy controls. Large and reliable effects in controls provide an important base for comparison for patients.

A major advantage provided by my paradigm is that performance on the task can highlight different forms of deficit. Specifically, my task can discern whether a patient has a problem at the evaluation stage or at the approach/avoid response stage. This dissociation has been demonstrated in my two patients; EO the confabulatory patient had a deficit in avoiding stimuli, but his evaluation skills were intact. He correctly classified items but his avoid response was absent. SH, the amygdala patient, had a deficit at the evaluation stage. She was slower to complete evaluation of unpleasant items but once classified her approach and avoid responses to these items were intact. Thus my paradigm has revealed that the evaluation stage and the response stage appear to depend on different brain areas and different systems. One can remain intact whilst the other experiences a deficit. The finding that the evaluation system may depend on the amygdala is consistent with previous research on this structure. The finding that the approach/avoid system may be housed and lateralized in the frontal lobes also supports previous theories (Davidson et al, 1990). The finding that a deficit in this system can provide an explanation for confabulation is a new discovery. It is possible that deficits in the approach/avoid system may underlie other disorders such as OCD, and so my paradigm may be important in investigating disorders in many types of patient.

Difficulties

The Order effect that occurs in my task does create a limitation when the explicit evaluation approach/avoid paradigm is extended to patient studies. The Order effect occurs because participants' responses speed up on each subsequent block in the experiment, but this effect is greatest when performing incongruent blocks first and then congruent blocks. This means that the congruency effect is influenced by the order in which the participants complete the blocks. It tends to be exaggerated in the incongruent then congruent order, and diminished in the congruent then incongruent order. This is acceptable when looking at the performance of a group, as the counterbalancing and inclusion of the Order factor in the analysis smoothes out this imperfection. It becomes more problematic when looking at the performance of individual patients. One possibility is to just use the incongruent then congruent order; this would lead to very large congruency effects in the controls, and so reducing or reversing this effect in the patients would be a strong test of the hypotheses. However, patients often find it difficult to understand the incongruent instructions. Neurologically healthy controls often need a moment to familiarize themselves with the oddity of being asked to touch unpleasant items and not touch pleasant items in the incongruent condition, and this difficulty is exaggerated in patients who can have additional memory or comprehension problems resulting from their injuries. So it is often essential to ease the patients into the task by having them perform the more easily understandable congruent block first. Thus the order effect creates a small problem that cannot easily be remedied.

Another problem was the pattern of results created by the right-handed participants. Because participants responded using their right hands their responses to touch the right side of the screen were especially quick. This meant that response

times to avoid left-sided stimuli, and approach right-sided stimuli were quicker than to avoid right-sided stimuli, and approach left-sided stimuli. This would be consistent with Davidson et al's (1990) lateralization theory but could also be a result of right-handed responses. Perhaps this could be remedied by alternating the response hand over the blocks with the necessary counterbalancing. This may work well for groups of participants, but might be more difficult to implement with individual patients with physical difficulties and would create counterbalancing problems in individuals.

My approach/avoid task used a touch or not touch basis for the responses. Whilst touching the valenced stimulus is a very direct measure of approaching, involving a direct reach towards the stimulus, the avoid response might be improved because the initial response involves moving the hand nearer to the valenced stimulus in order to get to the square. One possibility is that participants could start with their fingers in the centre of the screen, and then, move to touch the valenced stimulus, or the square, as in the current design. This would allow the responses to be categorical towards or away movements from each stimulus, without an initial movement towards the stimulus in the avoid response. That said, the current avoid response is not too much of a limitation as it produced large congruency effects. I have shown that the participants understanding of the situation is very important for the approach/avoid response, so it seems that as long as the participants understand the response as an avoid response this seems to be the most vital point. Using different approach and avoid responses would support this theory further.

An obvious difficulty is the inability to produce any congruency effects on an automatic evaluation approach/avoid task. Whilst it has now been claimed that these effects do not exist (Rotteveel and Phaf, 2004), and so the limitation is not confined to our research, an automatic approach/avoid task would have ruled out order effects,

made the lateralization of the stimuli tap lateral effects more precisely, and allowed investigation of automatic processing of valenced stimuli, in isolation and in comparison to the explicit evaluation of emotionally relevant stimuli, in healthy participants and in patients. However, as we have seen, even if automatic evaluation effects could be replicated in an approach/avoid paradigm, the effect size is so small that it would be an unsuitable method for single case studies.

Future directions for patient research.

I have produced a paradigm that is capable of measuring deficits in the evaluation or in the approach/avoid response in brain injury patients with unilateral damage. Despite some difficulties the task has proved successful in measuring the deficits in two types of patient. The results from the confabulatory patient are especially important as they suggest a new perspective from which to understand clinical disorders.

I have shown that confabulation might be understood from the approach/avoid perspective, and so it is possible that other disorders might also result from an imbalance in this system. It would therefore be an important step to examine how patients with different disorders respond on our task. In particular I would be interested to examine the responses of patients with Obsessive Compulsive Disorder (OCD). OCD is thought of as a mirror syndrome for confabulation (Hirstein, 2005) and therefore may result from the opposing imbalance that causes confabulation. That is OCD might be understood as an overactive avoid system, or an underactive approach system. Testing OCD patients on the explicit evaluation approach/avoid task would improve the understanding of this disorder and the approach/avoid system.

My dual route model of the approach/avoid predisposition.

Following Chen and Bargh (1999) many experiments have shown that explicit evaluation leads to an automatic predisposition to approach or avoid. Chen and Bargh (1999) do not explicitly outline a model for the mechanism linking evaluation and response. But it seems that they are suggesting a simple mechanism in which stimuli are automatically, or explicitly, evaluated, and once evaluated positive items predispose a flex response and negative items predispose an extend response, Figure 1 overleaf. Based on the experiments from this thesis I would suggest a more complex model that is influenced by contextual factors and is based on semantics rather than simple motoric actions, Figure 2 overleaf.

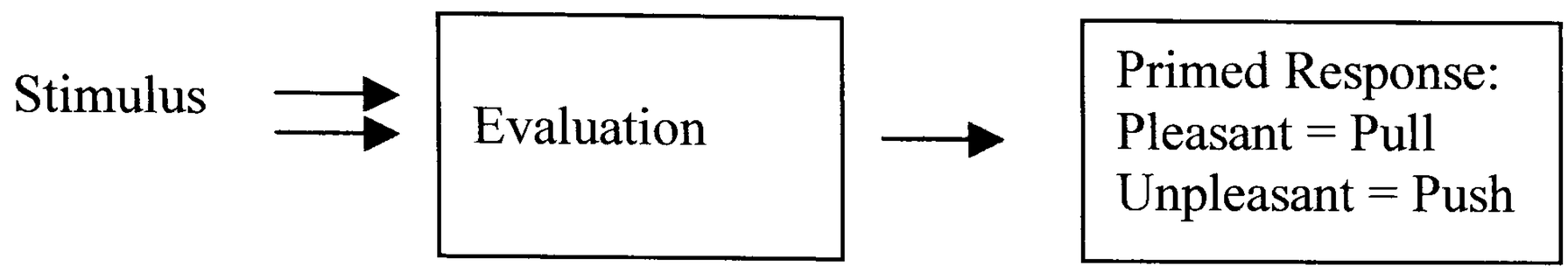

Figure 1. A simple model based on Chen and Bargh (1999)

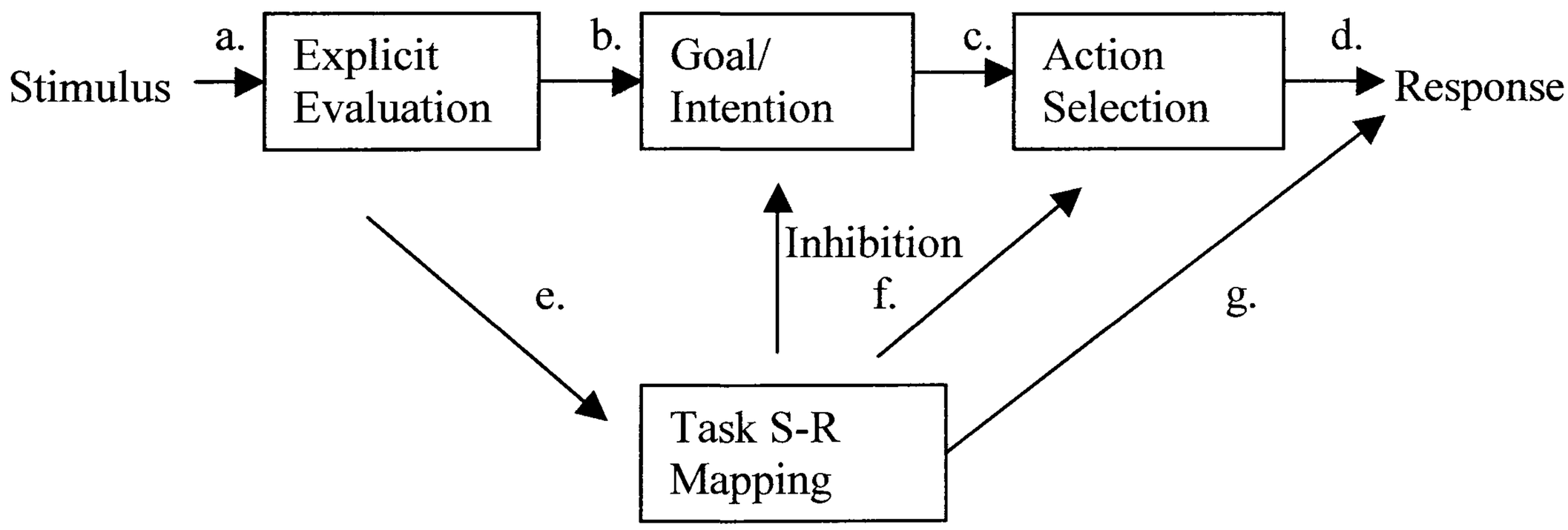

Figure 2. A diagram of my proposed model.

For both Figures, automatic processes are depicted by blue arrows and controlled processes depicted by black arrows. Both models will be explained in detail on the following pages.

The work by Chen and Bargh (1999) suggests the model depicted in Figure 1. In this model the automatically, or explicitly, evaluated stimulus automatically primes a pull response in the presence of pleasant stimuli, and a push response in the presence of unpleasant stimuli. Thus, these responses can be executed more easily and quickly than their alternatives.

My model differs from that of Chen and Bargh (1999). Firstly, my model is specifically for explicit evaluation because I did not find any link between automatic evaluation and approach/avoid behaviours. Secondly, it differs in that my proposed automatic route involves extra stages. These stages show that the automatic route can be flexible and that the behaviours produced depend upon contextual factors. Finally, my model is a dual route model comprising an automatic route, where the explicitly evaluated stimulus automatically activates a response, and a controlled route in which the automatically activated response can be inhibited allowing an alternative response to occur. Thus my model proposes the following:

Both automatic and controlled routes start at Stage a. At **Stage a**. the evaluation of the stimuli needs to be explicit. In Chapter 3 I demonstrated that large congruency effects occur following explicit evaluation, whilst in Chapter 4 I demonstrated that congruency effects are absent following automatic evaluation. Thus, it seems that automatically produced approach/avoid behaviours only occur following explicit evaluation.

Stages b c and d constitute the automatic route. The evidence for the automaticity of this route is that despite the fact that participants have no intention to respond more quickly in one condition than in another, the congruent behaviours are still produced more quickly than the incongruent behaviours (Chapter 3, Expt 1)

suggesting that the former are primed unintentionally. Further evidence for automaticity is that the advantage for congruent behaviours disappears as the time allowed to process the stimuli before responding increases (as seen in Chapter 3 Expt 2) Thus, this route decays over time, as expected with automatic responses.

Stage b. Following explicit evaluation the goal of the behaviour is determined automatically. Individuals unintentionally want to approach pleasant and avoid unpleasant outcomes. The experiments in Chapter 3 show that approaching pleasant and avoiding unpleasant stimuli are faster than the opposing responses despite the fact that the behaviours needed are not push and pull movements. So the primed responses must be based on the more abstract goal of approach pleasant/avoid unpleasant than just pleasant = pull, unpleasant = push. The goal can also have another level; firstly there is the goal to approach pleasant and avoid unpleasant, but there can also be the goal of how to do this, for example one can avoid by not touching, or by pushing away. The experiments in Chapter 5 provide evidence for this showing that the goal or intention is very important in producing the response and that changing the goal, for example from *do not touch unpleasant* to *push unpleasant away*, can change the subsequently selected behaviour.

Stage c. The appropriate action is then selected based on the goal and the situational demands. So if the goal is to avoid by pushing the stimulus away an extension movement will be automatically primed. If the goal is to avoid by moving your hand away then a flex movement will be automatically primed. This stage selects the best approach or avoid action based on the previous stage.

Stage d. These appropriate actions can then be executed, but the controlled route must provide some sort of check before the behaviours are produced (**stage g**). Individuals do not produce responses to all valenced stimuli. So whilst the rest of the

stages in this automatic route are unintentional and occur without deliberative thought, the response itself is not reflexive and will not occur if the participant does not wish it to. So whilst this last stage is automatic in the sense that these behaviours unintentionally occur more quickly then their opposites, it is monitored by the controlled route, and so this does have a non-automatic element.

Stages e. f. and g. constitute the controlled route. The automatically predisposed behaviours are not always produced but can be actively suppressed. Chapter 3 shows that alternative responses, such as the Incongruent movements, can be performed, but these take longer to be executed as the preferred action, the predisposition, needs to be overridden. It seems that this process of inhibition, or feedback, could take place at any stage along the automatic route. This feedback could change the goal of the behaviour, an individual could decide to approach an unpleasant item instead of avoiding it, and then prepare a response in a controlled manner. Feedback from the controlled route could also change the selected response; an individual could override a primed response and decide to make an alternative response, or no response at all. It is likely that this latter stage always occurs to some extent as a sort of checking process; that is although the behaviours might be primed they are not necessarily produced unless desired.

Thus, in comparison to Chen and Bargh (1999), in my model there are extra stages within the automatic route. Specifically, instead of the evaluation directly producing a specific motor response, I propose that there is a stage where the intended goal is automatically determined, and then there is a stage where the outcomes of the possible behaviours are automatically determined and the behaviours that will produce the goal are automatically produced, leading to the response. Thus, whilst

these extra stages are automatic they involve a degree of flexibility based on contextual factors.

My dual route model, comprising an automatic route, and a controlled route, is similar to the dual route model linking perception and action proposed by Eimer, Hommel, and Prinz (1995). The sensory codes initiated by a stimulus are thought to be linked to the motor codes involved in a response by a controlled process of translation, in which the individual understands, or plans to carry out, task instructions. Eimer et al argued that there is also a more direct route in which the stimulus can evoke a response automatically. They proposed another level beyond that of the distinct and incommensurable sensory and motor codes. Specifically they suggested that there are event codes initiated by the stimulus and if these are similar and overlap with response codes, then these response codes could be activated automatically without the need for any controlled translation process. Thus, this model proposes a direct route in which the stimulus activates the response automatically, and an indirect route in which the stimulus can lead to a response based on an intended and controlled translation process (Kornblum. Hasbroucq, and Osman 1990; De Jong, Liang, and Lauber 1994). Importantly it is suggested that these routes occur in parallel (Eimer et al 1995).

Several pieces of research support this model. The Simon effect, for example, shows that responses can be initiated automatically; the irrelevant spatial location of the target corresponds to the required responses and automatically affects the ease and speed of which the response is executed. This effect might be explained using the controlled route hypothesis, in which facilitation of the translation processes occurs (Wallace, 1971). But Hommel (1993; 1995; 1996) has provided a series of experiments showing that this is not the case. In particular, Hommel (1995; 1996)

demonstrated that Simon effects occurred even when the experimental design ensured that the translation process had been completed before the response was possible. Thus the irrelevant spatial location of the target affected the response even though the translation process had already occurred. So the irrelevant feature must be exerting an effect at a stage other than translation, thus providing evidence for a second, automatic, route. Further evidence for this automatic route comes from the time-course of the Simon effect. Hommel (1993) has shown that the Simon effect decays, and even reverses, as the time taken to process the stimuli is increased, as would be expected if it were an automatic process.

This behavioural evidence has also been supported by electrophysiological evidence (Eimer et al, 1995). The experimental paradigm separated automatic and controlled processes, by introducing a pre-cue that preceded the target stimuli and indicated with a high probability the spatial location of the upcoming target. Over a number of experiments Eimer at al showed that the pre-cue primed the corresponding response between 200-500ms, reflecting automatic response activation, and that this activation then returns to baseline, reflecting a decay of these automatic processes. A second response activation then occurs reflecting the controlled response to the stimulus. Thus, this provides evidence that automatic response activation is independent of the controlled processes that produce the required response. It seems that a response is automatically activated and the controlled route can then select it or inhibit it, in order to produce the correct response.

Strong evidence then exists that the link between action and perception is more complex than a serial model linking stimulus to response via a single process. Indeed, Eimer et al (1995) argued "there is more going on in the information processing system than a single stream of information from receptor stimulation to

muscle contraction." The experiments from this thesis make a similar argument in suggesting a dual route model, but one in which the automatic route is more complex and flexible than previously suggested.

My model produces a detailed mapping of the processes involved in the approach/avoid response. In addition to improving the understanding of the approach/avoid response in healthy individuals I can also start to propose the stages at which the patients were impaired. The patient based work revealed that amygdala damage leads to a problem at the evaluation stage. The amygdala patient is impaired when evaluating unpleasant stimuli but once evaluated the other stages are intact. The confabulatory patient, EO, does not have a problem with evaluation; his evaluation is intact and his problem lies at a later stage. His performance on the approach/avoid task cannot tell us exactly where this problem is, but I would suggest that it occurs at the goal forming stage. At this stage healthy participants would automatically want to avoid unpleasant outcomes, but this seems absent for EO. Without this goal to avoid, the behaviours needed to avoid would not be activated at the action selection stage, and so would show no advantage over opposing behaviours. Thus, the two patients from this thesis show deficits at different stages. My model provides an important tool to help map out the different brain areas involved at each stage in the approach/avoid response.

Conclusions

My experiments have shown that an involuntary predisposition to approach pleasant and avoid unpleasant items occurs after explicit evaluation, and this predisposition is modified by situational demands, rather than being based on simple valence-specific push and pull movements. Despite producing a large congruency

effect using an explicit evaluation task it appears much harder to produce any congruency effects on a similar task with automatic evaluation. It is still unclear under which conditions this automatic evaluation and approach/avoid predisposition exists.

My explicit evaluation approach/avoid paradigm created for patients proved successful and showed that disorders might be understood as an imbalance of the approach/ avoid system. The paradigm can be used to elucidate whether a deficit lies at the evaluation stage or at the approach/avoid response stage and can also help to determine the brain structures involved in the evaluation and approach/avoid response.

This paradigm is a major advancement to the existing evaluation and approach/avoid research allowing these topics to be studied in patients with unilateral damage. It also contributes to existing patient based work by introducing a new perspective from which to view many disorders, and by producing a test of approach/avoid responses for patients. Thus, it is hoped both areas will benefit from the research presented in this thesis.

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Appendix

Tables showing response times at the reaction time (rt), movement time (mt) and total time (tt) stage for the critical effects in each experiment.

The analyses include factors of Side (Left/Right), Valence (Pleasant/Unpleasant), Behaviour (Approach/Avoid), Task (Congruent/Incongruent), Order (CI/IC), Stimulus Type (Picture/Word), and where relevant Delay (Short/medium/Long), and Response Effects (Towards/Away) or (Valid/Invalid).

To conduct the analysis response times were computed and then iteratively trimmed to include scores that are 3 standard deviations from the mean for each condition and each participant. This is done separately for the rt, mt, and tt. Subsequently, there may be cases that are outliers in one analyses, for example the rt, but are not outliers in the mt, thus the rt and mt may not add up exactly to the tt in these tables. Tables show means and standard deviations (in brackets).

Chapter 3. Explicit Evaluation Experiments. Tables 1 and 2 showing which stages the congruency effects are occurring.

Table 1. Explicit Evaluation Experiment. Means and Standard Deviations (in brackets) for the Congruent and Incongruent conditions. A congruency effect is occurring descriptively at all stages. It is statistically significant at the mt and tt stages.

N=20	Con	Incon	F	p
rt	239.8 (161.5)	267.9 (178.8)	1.00	.332
mt	614.1 (120.8)	687.3 (183.1)	9.84	.006
tt	893.9 (169.6)	1004.0 (269.4)	8.86	.008

Table 2. Explicit Evaluation Experiment with Delay. This Table shows the size of the congruency effect at each stage. The congruency effect reduces over time.

	Incongruent minus Congruent (ms)				
	Short	Medium	Long	F	p
rt	41	24	1.2	1.49	.238
mt	115	43	58	1.901	.161
tt	159	67	45	2.37	.105

Chapter 4. Automatic Evaluation Experiments. Tables 3 – 8 showing that no predicted congruency effects occur at any stage for any automatic experiment.

Table 3. Automatic Experiments 1. Means and Standard Deviations (in brackets) for the Congruent and Incongruent conditions. No congruency effects occur at any stage.

N=12	Con	Incon	F	p
rt	263.5 (86.6)	263.5 (80.5)	0.000	.989
mt	405.6 (87.5)	403.6 (85.6)	0.305	.592
tt	669.3 (146.4)	671.5 (151.1)	0.380	.550

Table 4. Automatic Experiments 1. This table shows the results in more detail looking at the Behaviour by Valence interaction. No congruency effects are occurring at any stage.

N=12	Con		Incon		F	p
	Approach Pleasant	Avoid Unpleasant	Approach Unpleasant	Avoid Pleasant		
rt	262.1 (88.7)	264.9 (85.4)	264.1 (82.6)	262.8 (79.1)	0.000	.989
mt	408.4 (92.8)	402.7 (82.7)	402.8 (91.9)	404.5 (79.7)	0.305	.592
tt	669.9 (152.8)	668.7 (141.2)	672.0 (166.5)	671.0 (135.7)	0.380	.550

Table 5. Automatic Experiments 2. This experiment introduced a variable delay. This table shows that the sizes of the congruency effects at each delay. I might have expected a congruency effect at the short delay, but this did not occur.

N=12	Incongruent minus Congruent				
	Short	Medium	Long	F	p
rt	1	-10	19	0.695	.510
mt	2	-12	-11	0.147	.864
tt	-7	-14	-9	0.041	.960

Table 6. Automatic Experiments 3. This experiment removed the pleasant items. I was expecting faster responses to avoid than approach for unpleasant but not for neutral items. This did not occur at any stage.

	Approach			Avoid				
N=12	High Arousal Unpleasant	Low Arousal Unpleasant	Neutral	High Arousal Unpleasant	Low Arousal Unpleasant	Neutral	F	p
Rt	350.7 (69.5)	351.7 (76.1)	354.7 (77.3)	359.9 (75.8)	354.2 (70.0)	353.4 (74.1)	1.785	.191
Mt	411.3 (58.5)	407.5 (54.8)	408.8 (57.8)	415.2 (52.0)	415.0 (52.6)	415.9 (53.0)	0.282	.757
Tt	766.1 (104.1)	760.8 (107.7)	760.4 (106.8)	780.2 (100.0)	774.0 (98.8)	773.8 (100.3)	0.007	.993

Table 7. Automatic Experiment 4. In this experiment participants rated half of the stimuli before the task and half after. I expected a congruency effect for stimuli rated before but not after. This did not occur at any stage.

	Stimuli Rated before Experiment				Stimuli Rated After Experiment					
	Con		Incon		Con		Incon			
N=8	App Pl	Av Unpl	App Unpl	Av Pl	App Pl	Av Unpl	App Unpl	Av Pl	F	p
rt	394.4 (102.1)	385.7 (91.3)	385.8 (94.9)	379.6 (88.8)	380.9 (98.6)	391.4 (105.7)	390.8 (106.4)	383.8 (92.2)	1.696	.234
mt	466.9 (144.9)	476.3 (164.6)	477.9 (142.7)	458.7 (146.1)	476.3 (153.9)	463.2 (162.8)	477.2 (158.7)	458.6 (157.0)	0.017	.900
tt	868.0 (164.2)	876.2 (180.8)	867.3 (170.5)	841.1 (159.2)	868.8 (162.4)	868.1 (206.9)	884.5 (192.3)	849.3 (183.1)	2.141	.187

Table 8. Automatic Experiment 5. Participants rated all stimuli Before or all stimuli After the task. Congruency effects might be expected in the Before condition but not in the After condition. This did not occur at any stage. The interaction was Significant at the rt stage but this seems to reflect a trend in the opposite direction to the predicted effect.

	Rated all Stimuli before Experiment				Rated all Stimuli After Experiment					
	Con		Incon		Con		Incon			
N=36	App Pl	Av Unpl	App Unpl	Av Pl	App Pl	Av Unpl	App Unpl	Av Pl	F	p
rt	363.6 (86.7)	356.9 (75.9)	357.4 (76.3)	355.0 (73.5)	351.7 (62.9)	353.6 (68.6)	353.2 (63.8)	354.7 (64.1)	5.770	.022
mt	419.9 (114.5)	410.8 (123.1)	429.5 (120.1)	413.0 (111.7)	447.7 (70.7)	436.7 (81.7)	457.4 (87.6)	436.4 (75.7)	0.028	.868
tt	791.8 (146.6)	784.0 (166.1)	792.5 (153.6)	773.6 (139.4)	809.8 (94.6)	798.7 (112.0)	813.6 (105.8)	794.7 (97.4)	0.589	.448

Chapter 5. Response Effects Experiments. Tables 9-11 showing that the effects are occurring at all stages.

Table. 9. Response Effects 1. Response Effects with no emphasis on instructions. The Congruency effect holds descriptively for both conditions at all stages, and is significant at the tt stage.

N= 24	Towards		Away			
	Con	Incon	Con	Incon	F	P
rt	301.3 (103.0)	317.7 (119.4)	296.4 (114.7)	334.5 (150.3)	0.405	.532
mt	509.5 (116.4)	572.0 (215.3)	577.8 (181.4)	602.3 (219.2)	0.554	.465
tt	819.1 (144.5)	905.3 (230.0)	891.6 (178.6)	953.9 (221.7)	4.207	.054

Table 10. Response Effects 2. Response Effects Experiment with emphasis on instructions. The Congruency effect reverses for Away conditions at all stages.

N=20	Towards		Away			
	Con	Incon	Con	Incon	F	P
rt	301.4 (103.0)	317.7 (119.4)	367.4 (91.7)	319.9 (102.4)	5.014	.037
mt	509.5 (116.4)	572.0 (215.3)	683.4 (269.2)	617.5 (180.7)	3.298	.084
tt	819.1 (144.5)	905.3 (230.0)	1068.3 (272.4)	949.5 (158.0)	8.911	.007

Table 11. Response Effects 3. Noisy Faces. This experiment had a non-spatial response effect. The congruency effect reverses descriptively for invalid conditions at all stages, and is statistically significant at the tt stage.

N=12	Valid		Invalid			
	Con	Incon	Con	Incon	F	P
rt	260.2 (117.3)	263.7 (127.5)	261.1 (118.2)	255.8 (115.5)	1.705	.218
mt	459.9 (128.3)	478.0 (128.2)	458.4 (144.1)	437.9 (120.2)	2.730	.127
tt	728.2 (150.3)	756.5 (160.5)	734.3 (179.6)	707.4 (148.1)	6.350	.028

Patient Chapters. Tables 12 – 13 showing that the deficits occur at the mt and tt stages.

Chapter 6. Confabulation Patient.

Table 12. A comparison of Age-matched Controls and Patient EO. The congruency effect is significant at all stages for the age-matched controls. Interestingly for the rt the trend is in the opposite direction to the predicted effect. EO's pattern of results is similar to controls at each stage with the exception that the effects are exaggerated because his avoid conditions are particularly slow. This occurs at the mt and tt stages.

	Con		Incon		F	p
Age-Match Controls N=6	Approach Pleasant	Avoid Unpleasant	Approach Unpleasant	Avoid Pleasant		
rt	163.1 (77.5)	162.7 (77.4)	148.5 (67.9)	149.5 (69.7)	4.885	.078
mt	954.4 (189.2)	**1034.2 (169.2)**	1180.9 (331.1)	**1196.8 (243.7)**	91.984	.000
tt	1123.6 (206.1)	**1198.3 (194.7)**	1322.4 (338.9)	**1348.3 (246.9)**	52.986	.001

EO	Approach Pleasant	Avoid Unpleasant	Approach Unpleasant	Avoid Pleasant
rt	174.1 (6.3)	178.9 (1.5)	157.3 (2.5)	153.1 (1.4)
mt	957.3 (95.5)	**1162.2 (12.1)**	1156.9 (21.1)	**1313.3 (108.1)**
tt	1106.1 (62.8)	**1386.4 (181.8)**	1371.3 (285.4)	**1554.6 (459.0)**

Table 13. A comparison of Age-matched Controls and Patient SH. This table shows congruency effects for stimuli presented on the Left and on the Right. For the age-matched controls the congruency effect holds for stimuli on both sides for the mt and tt stages. The three-way interaction of Side by Valence by Behaviour is significant but just shows that the effect is smaller for unpleasant items on the right. SH shows that her congruency effects occur for all conditions. In general she is slower to respond than controls but the RSDT shows that the effect is significant for the tt unpleasant items on the right. This pattern occurs for the mt too.

	Left				Right					
	Con		Incon		Con		Incon			
Age Match N=6	App Pl	Av Unpl	App Unpl	Av Pl	App Pl	Av Unpl	App Unpl	Av Pl	F	p
rt	163.7 (80.3)	163.1 (80.2)	150.1 (69.8)	149.2 (72.3)	162.4 (78.1)	162.3 (78.2)	147.1 (69.1)	149.7 (70.3)	0.234	.649
mt	969.8 (198.4)	1029.1 (184.2)	1258.5 (369.2)	1196.7 (244.1)	939.1 (187.1)	1039.2 (160.8)	1103.2 (282.5)	1196.9 (254.1)	9.948	.025
tt	1149.6 (225.1)	1195.2 (197.1)	1400.6 (377.5)	1346.7 (246.6)	1097.6 (191.6)	**1201.4 (201.1)**	**1244.1 (290.3)**	1349.9 (258.2)	5.587	.064

SH	App Pl	Av Unpl	App Unpl	Av Pl	App Pl	Av Unpl	App Unpl	Av Pl
rt	139.0	150.8	174.3	163.9	146.0	152.8	175.0	170.4
mt	1192.8	1217.0	1644.0	1378.2	1145.0	1582.7	1766.9	1435.3
tt	1370.8 (381.3)	1385.1 (267.5)	1947.4 (627.9)	1601.3 (427.8)	1338.0 (345.2)	**1705.9 (432.0)**	**1954.6 (490.4)**	1641.0 (282.6)